RCA

MICROWAVE DEVICES

NEW PRODUCT DESCRIPTION (PRELIMINARY)

Developmental Type A-1309

One-Watt S-Band Traveling Wave Tube With Improved Packaging

DESCRIPTION

A 1-watt, S-band, wideband, medium-power amplifier. Ruggedized for use in airborne systems.

Frequency	1.9 – 4.1 Gc	Size	13" x 1-3/4"
Gain (small signal)	35 db (min.)	Weight	2.5 lbs.
Power output	1 watt	Temperature range	-54^{o} to $+120^{o}$C
E_{coll}	1100 volts	Vibration	10 g's 50-1500 cps
E_{helix}	1000 volts	Shock	20 g's 11 milliseconds
E_{anode}	1000 volts		
I_{coll}	30 ma		
I_{helix}	2 ma		

POSSIBLE USES

Airborne ECM systems Drone systems Test equipment

For further information or application assistance on this developmental type or other RCA tubes, please contact your field representative at the RCA District Office nearest you or manager, Microwave Marketing. (The list is on the back of this sheet.)

RADIO CORPORATION OF AMERICA
Electronic Components and Devices
Microwave Tube Operations Department
Harrison, New Jersey

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202 Fe 7-8500
J. W. Kirschner (John) District Manager

CENTRAL

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312 827-0033
G. S. Scholes (George) District Manager

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Dave Koch, District Representative

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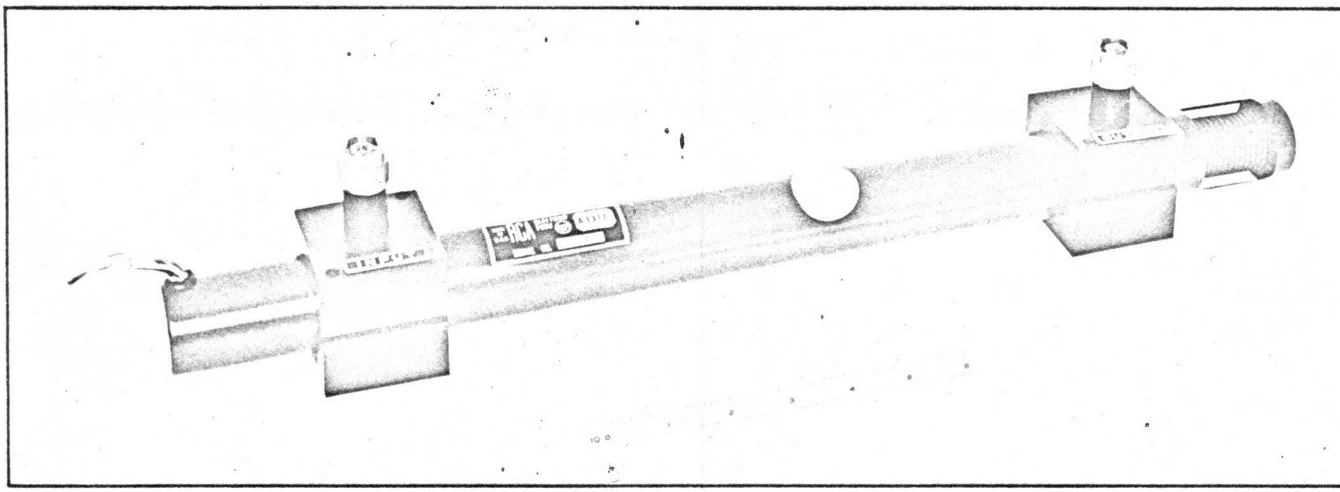
F. E. Gehrke Manager, Microwave Marketing

RCA
DEVELOPMENTAL
MICROWAVE DEVICES

NEW
PRODUCT
DESCRIPTION

Medium Power P-Band Traveling-Wave Tube

Type A1317



DESCRIPTION

RCA-A1317 is a traveling-wave-tube amplifier yielding a minimum of 20 watts in P-band.

Frequency	0.75–1.00 GHz	Anode Voltage	1400 volts
Min. Power Output	20 watts	Collector Current	55 mA
Small-Signal Gain	30 dB	Size	19.938 x 2.188 x 2.125 inches
Helix Voltage	1650 volts	Weight (Approx.)	5 lbs
Collector Voltage	1625 volts	Cooling	Forced air

POSSIBLE USES

Test Equipment

Communications Systems

For further information or application assistance on this device, contact your RCA Field Representative or write Microwave Marketing. (See addresses on back of this sheet).

RADIO CORPORATION OF AMERICA
ELECTRONIC COMPONENTS & DEVICES, HARRISON, N. J.

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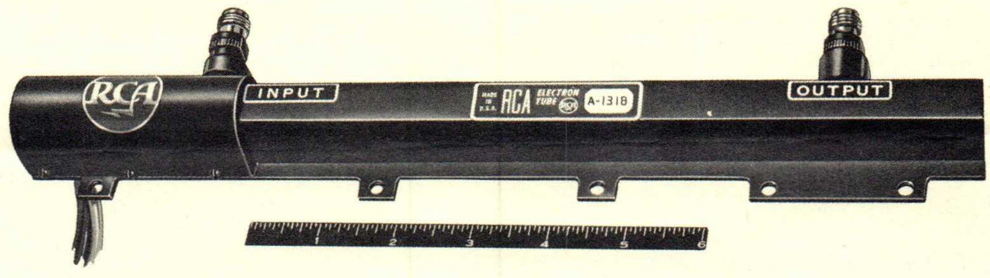
RCA
MICROWAVE DEVICES

NEW PRODUCT DESCRIPTION
(PRELIMINARY)

Type A-1318

4-Gc Traveling-Wave Tube For Satellites



DESCRIPTION

A ruggedized metal-ceramic traveling-wave tube for use in space systems. Efficiency is constant over the range of power output. Uses a single-stage collector. Operable during launch.

Frequency	3.0 — 4.5 Gc	Width	1.80 inches (max. baseplate)
Power output	5 - 20 watts	Cooling	Conduction
Gain (sat.)	40 db	Leads	Silicone rubber
Noise figure	23 db	Pressure	10^{-5} to 775 mm Hg
Efficiency (overall, including heater)	40%	Temperature (baseplate)	-40°C to +85°C
Cathode current density	65 - 140 ma/cm^2	Shock	40 g's, 8 milliseconds
Weight	1.5 lbs.	Vibration	15 g's, 5 - 2000 cps, sinewave; 0.12 g^2/cps, random
Length	12 inches		
Height	1-1/4 inches (max.)	Acceleration	20 g's (unidirectional)

POSSIBLE USES

Communication satellites

Terrestrial airborne systems

For further information or application assistance on this developmental type or other RCA tubes, please contact your field representative at the RCA District Office nearest you or manager, Microwave Marketing. (The list is on the back of this sheet.)

RADIO CORPORATION OF AMERICA
Electronic Components and Devices
Microwave Tube Operations Department
Harrison, New Jersey

1/6/65

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T.R.D.

Preliminary and Tentative Data

RCA Developmental Type, Dev. No. A2346F *

INDUSTRIAL TUBE PRODUCTS — TUBE TRIODE — SUPER POWER

* The number identifies a particular laboratory tube design but the number and identifying data are subject to change. No obligations are assumed as to future manufacture unless otherwise arranged.
¢ Indicates a change. Place next to change item.

RCA developmental type A2346F is a ceramic envelope, water cooled, super power triode intended for use in pulse power amplifier service at frequencies up to 300 Mc. The tube is especially suited for use in long range search radar and high power particle accelerator applications.

In short pulse services with a pulse duration of 25 microseconds and a duty factor of 0.01, the A2346F is capable of providing a peak rf pulse power output of 5 MW at a frequency of 250 Mc. Under these same short pulse conditions, the tube should be capable of producing a useful peak power output of approximately 10 MW. Furthermore, in long pulse service with a pulse duration of 2 milliseconds and a duty factor of 0.06, the A2346F should be capable of providing a peak rf pulse power output of 5 MW at a frequency of 250 Mc.

The A2346F features an internal electrode structure consisting of a precisely spaced cylindrical array of 96 identical triode units each employing a thoriated tungsten filament strand to provide high emission, long life and economical operation.

The tube employs double-ended construction with symmetrically placed ceramic insulators and coaxial contact terminals at either end of the cylindrical tube structure. This arrangement permits placement of the active tube elements at the electrical center of a half-wave length portion of a resonant cavity, and allows operation at higher frequencies than are possible with single-ended tubes of comparable power capabilities.

GENERAL DATA

Electrical

Filament, Multistrand Thoriated Tungsten

Typical Current	6600 @	amperes
Maximum Current	7200 @	amperes
Initial Surge Starting Current **	Must never exceed 2000 amperes, even momentarily	
DC Voltage ***		
For the typical current	3.1	min. volts
	4.2	max. volts
For the maximum current	4.65	max. volts

For further information or application assistance on this developmental type or other RCA tubes, please contact your field representative at the RCA District Office nearest you.

WHitehall 4-2900
Suite 1154
Merchandise Mart Plaza
Chicago 54, Ill.

HUmboldt 5-3900
744 Broad St.
Newark 2, N. J.

RAymond 3-8361
6355 E. Washington Blvd.
Los Angeles 22, Calif.

RADIO CORPORATION OF AMERICA
ELECTRON TUBE DIVISION — HARRISON, N. J.

T506-1 3/59

Sheet 1 of 18
Date March 29, 1960
Supersedes PTO-920-19 11-21-56
(GIVE DATE)

Preliminary and Tentative Data (Cont'd)

RCA Developmental Type, Dev. No. A2346F

Electrical (Continued)

Minimum Heating Time at Operating Current	60	seconds
Direct Interelectrode Capacitances		
Grid to Anode	150	uufd
Grid to Cathode	1600	uufd
Anode to Cathode	Less than 1.0	uufd
Amplification Factor	250	

Mechanical

Operating Position	Vertical, either end up	
Overall Length	17.0 max.	inches
Maximum Diameter	14.125 max.	inches
Terminal Connections	See Dimensional Outline	
Weight		
Uncrated	190	pounds
Crated	355	pounds

Air Cooling

It is important that the temperature of any external part of the tube not exceed 150°C. In general, forced air cooling of the ceramic bushings and the adjacent contact areas will be required if the tube is used in a confined space without free circulation of air. Under such conditions, provision should be made for blowing an adequate quantity of air across the ceramic bushings and adjacent terminal areas to limit their maximum temperature to 150°C.

Water Cooling

Water cooling of the upper and lower grid terminals, grid-cathode structure and the plate is required. The water flow must start before application of any voltages in order to purge the system of bubbles and should continue for several minutes after removal of all voltages. Interlocking of water flow through each of the cooled elements with all power supplies is recommended to prevent tube damage in case of failure of adequate water flow. The use of distilled water is essential.

Water Flow

	Typical Flow GPM	Absolute Minimum Flow GPM	Pressure Differential for Typical Flow # PSI	Maximum Input Gauge Pressure ## PSIG
To Plate: Total Flow for Two Parallel Input and Output Water Paths				
For Plate Dissipations up to 300 KW.....	160	150	40 max.	90
For Plate Dissipations up to 150 KW.....	100	90	30 max.	90
For Plate Dissipations up to 50 KW......	40	35	5 max.	90
To Upper Grid Cooling Course............	3	2	20 max.	90
To Lower Grid Cooling Course............	3	2	20 max.	90
To Grid-Cathode Cooling Course..........	35	30	30 max.	60

Resistivity of Water at 25°C
Plate and Grid Coolant.. 1 min. megohm-cm
Grid-Cathode Coolant.. 5 min. megohm-cm

Insulating Ceramic Bushing Temperature.......................... 150 max. °C
Metal Surface Temperature....................................... 150 max. °C
Water Temperature from Any Outlet............................... 70 max. °C
Minimum Storage Temperature ###.................................. -65 max. °C
External Gas Pressure... 65 max. PSIG ##

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

Plate Pulsed Amplifier

Maximum Ratings, Absolute Values

For a maximum "on" time @ of 25 microseconds in any 2500 microsecond interval	For frequencies up to 300 Mc	
Peak Pulse Plate Supply Voltage @@..............	45,000 max.	volts
Peak Pulse Grid-Cathode Bias Voltage @@@........	-250 max.	volts
Peak Plate Current from Pulse Supply............	300 max.	amperes
Peak Pulse Cathode Current Ø....................	500 max.	amperes
Average Plate Dissipation.......................	100,000 max.	watts

Typical Operation

With rectangular waveshape and duty factor ØØ of 0.006	At 250 Mc	
Peak Pulse Plate Supply Voltage @@..............	34,000	volts
Peak Pulse Grid-Cathode Bias Voltage @@@........	-100	volts
Peak Plate Current from Pulse Supply............	260	amperes
Peak Pulse Cathode Current Ø....................	400	amperes
Peak Pulse Driving Power........................	150,000	watts
Useful Peak Power Output........................	5,000,000	watts

Plate Pulsed Amplifier

Proposed Maximum Ratings, Absolute Values		
For a maximum "on" time Θ of 2200 microseconds in any 34,000 microsecond interval	For frequencies up to 300 Mc	
Peak Pulse Plate Supply Voltage ΘΘ	40,000 max.	volts
Peak Pulse Grid-Cathode Bias Voltage ΘΘΘ	-250 max.	volts
Peak Plate Current from Pulse Supply	275 max.	amperes
Peak Pulse Cathode Current Ø	550 max.	amperes
Average Plate Dissipation	300,000 max.	watts

Proposed Typical Operation		
With rectangular wave shape and duty factor ØØ of 0.06	At 250 Mc	
Peak Pulse Plate Supply Voltage ΘΘ	35,000	volts
Peak Pulse Grid-Cathode Bias Voltage ΘΘΘ	-100	volts
Peak Plate Current from Pulse Supply	265	amperes
Peak Pulse Cathode Current Ø	530	amperes
Peak Pulse Driving Power	160,000	watts
Useful Peak Power Output	5,000,000	watts

Proposed Maximum Ratings, Absolute Values		
For a maximum "on" time Θ of 25 microseconds in any 2500 microsecond interval	For frequencies up to 300 Mc	
Peak Pulse Plate Supply Voltage ΘΘ	65,000 max.	volts
Peak Pulse Grid-Cathode Bias Voltage ΘΘΘ	-500 max.	volts
Peak Plate Current from Pulse Supply	325 max.	amperes
Peak Pulse Cathode Current Ø	500 max.	amperes
Average Plate Dissipation	150,000 max.	watts

Proposed Typical Operation		
With rectangular waveshape and duty factor ØØ of 0.01	At 250 Mc	
Peak Pulse Plate Supply Voltage ΘΘ	60,000	volts
Peak Pulse Grid-Cathode Bias Voltage ΘΘΘ	-300	volts
Peak Plate Current from Pulse Supply	280	amperes
Peak Pulse Cathode Current Ø	430	amperes
Peak Pulse Driving Power	200,000	watts
Useful Peak Power Output	10,000,000	watts

@ The specified maximum filament current for each tube is a maximum rating which should not be exceeded, even momentarily, during operation of the tube. The life of the tube can be conserved by operating the filament at the lowest current which will enable the tube to provide the desired power output. Because the filament when operated near the maximum value usually provides emission in excess of any requirements within the tube ratings, the filament current should be reduced to a value that will give adequate but not excessive emission for any particular application. Good regulation of the filament voltage is, in general, economically advantageous from the viewpoint of tube life.

** The filament current should be gradually raised to operating value in not less than 30 seconds.

*** Measured between KLRF and KURF (see Tube Symbol).

Measured directly across cooled element.

With the gauge located in an area where the maximum pressure external to the gauge is one atmosphere.

Water cooled elements must be free of water before storage or shipment to prevent damage from freezing.

θ "On" time is defined as the sum of the durations of all the individual pulses which occur during the indicated interval. Pulse duration is defined as the time interval between the two points on the pulse at which the instantaneous value is 70% of the peak value.

θθ The magnitude of any spike on the plate voltage pulse should not exceed its peak value by more than 400 volts, and the duration of any spike when measured at the peak-value level should not exceed 10% of the maximum "on" time. 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.

θθθ Preferably obtained from a cathode bias resistor.

∅ Peak pulse cathode current is the total of the peak plate current from pulse supply and the peak rectified grid current.

∅∅ Duty factor is the product of pulse duration and repetition rate.

OPERATING CONSIDERATIONS

The maximum ratings in the tabulated data are limiting values above which the serviceability of the A2346F may be impaired from the viewpoint of life and satisfactory performance. Therefore, in order not to exceed those absolute ratings, the equipment designer has the responsibility of determining an average design value below each absolute rating by an amount such that the absolute values will never be exceeded under any normal condition of supply-voltage variation, load variation, or manufacturing variation in the equipment itself. Maximum ratings hold for operation up to 5000 feet. Under most conditions pressurized cavities will be required for operation at the indicated typical voltages to prevent flashover at the tube seals.

Best performance and maximum power output are obtained when the tube is operated at near class B conditions. When bias is used it is recommended that it be obtained from a cathode resistor.

The maximum insulating bushing temperature rating, the maximum metal surface temperature, the minimum storage temperature rating, the maximum outlet water temperature, and the maximum gauge pressures for the water inlets are tube ratings and should be observed in the same manner as other ratings.

The serial number which identifies each A2346F is stamped on the name plate located on the outside diameter of the plate terminal. Other numbers stamped on external tube surfaces are for manufacturing purposes only.

In transportation, handling and storage of the A2346F, care should be taken to protect the tube from rough handling that would damage the seals or other parts. NEVER ALLOW THE TUBE TO REST ON THE FILAMENT TERMINALS, UPPER RF CATHODE TERMINAL OR THE CERAMICS. (See Dimensional Outline.) The lifting plate is provided for convenience in installing or removing the tube from equipment. After the tube has been seated in the equipment, remove the lifting plate before the tube is placed in operation. Save the lifting plate so that it can be used to remove the tube from the equipment when desired.

It is recommended that the A2346F be tested upon receipt in the equipment in which it is to be used. Recommended "break in" treatment is described later. Before the tube is placed in operation, remove any foreign material adhering to it. After the tube has been tested and before it is placed in storage, the internal ducts should be blown free of water especially if the storage temperature will drop below 0°C (32°F). Care should be taken to prevent any foreign matter from entering the water connection at any time. As a safeguard, it is recommended that during storage the A2346F be completely enclosed in a protective plastic bag, and then sealed in the container in which it was received. When the tube is used under conditions in which the ambient temperature is below 0°C (32°F), precaution should be taken to prevent freezing of the water in the coolant ducts after power has been turned off.

Tube cleanliness is an important consideration. As with other high voltage equipment it is essential that external parts of the A2346F be kept free from accumulated dirt to minimize surface leakage and reduce the possibility of arc-over. Make it a regular practice to remove dirt from the surfaces of the tube at least twice a month, or more frequently if necessary to keep the tube clean. Particular care should be taken to prevent foreign particles from coming in contact with the re-entrant areas at the edge of the ceramic seals. Unless adequately protected, these areas collect dirt rapidly due to electrostatic forces and the nature of the air circulation around the tube.

The mounting used for the A2346F should hold the tube vertically with the upper lifting plate up. The entire weight of the tube should be supported by the upper or lower mounting surfaces. (See Dimensional Outline.) Provision should be made to avoid subjecting the tube to appreciable shock.

Because of the low voltage, high current filament, it is recommended that the filament connectors be kept short to minimize voltage drop. The use of coaxial filament connectors is recommended. The connector for the coaxial terminals of the filament should be of the coil spring, pressure contact type. The filament connectors should make firm, large surface contact. Caution should be exercised when assembling or disassembling the filament connectors, so that the filament terminals are not loosened. The filament connectors should always be rotated clockwise with respect to the tube, both for assembly and disassembly.

Connection to the plate terminal should also be of the spring contact type, bearing on the RF plate terminal contact areas.

When power is applied to the tube, there may be some motion of various parts of the tube and associated circuitry due to thermal expansion. In order that no undue stress is placed on the ceramic-metal seals of the tube, the terminal connectors should be flexible. This can be assured by providing floating concentricity rings to which the flexible contacts are fixed. RF circuit continuity should be provided through the concentricity rings. The connecting leads and water hoses should be installed so that the slack portion does not come close to or approach the body of the tube.

When connecting or disconnecting the water hoses and the electrical connections, it is essential that no undue stress be placed on the seals. The direction of water flow must be as indicated on the dimensional outline for both the plate and grid-cathode coolant flows.

An approximate value of the plate dissipation, which should not exceed the value shown under Maximum Ratings in the tabulated data, may be calculated from the following equation:

$$P_{watts} \text{ equals } n(t_0 - t_1) \times 264$$

in which t_1 is the temperature of the cooling water at the inlet to plate in degrees Centigrade, t_0 is the temperature of the water at the outlet in degrees Centigrade, and n is the number of gallons per minute of total flow for two parallel input and output water paths.

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, that is, after the filament has been operated at the rated typical current for the minimum heating time specified in the tabulated data.

A high-speed, electronic protective device must be used to remove the plate voltage within 10 microseconds in the event of abnormal operation such as internal arcing. The protective device employed to remove the plate voltage in any installation must be approved by an RCA field representative or by the nearest District Sales Office. In addition, the grid drive line should be provided with VSWR protection to remove drive power and plate voltage within 10 milliseconds in the event of abnormal changes in input VSWR during operation.

Circuit return from the plate should be made to the output-circuit-return grid terminals, identified on the tube symbol as GLORF and GUORF. Connection to the output-circuit-return terminals should be made by a system of fingers bearing on the grid output terminal contact areas.

The rated plate voltage of this tube is extremely dangerous to the user. 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 cannot 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 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 water cooling system consists in general of two sources of cooling water, a very high quality system to supply water for the grid-cathode cooling course and a high quality system to supply water to the plate and grid cooling courses. The two systems should be connected to the respective cooling courses through a suitable flexible feed pipe system. Where potentials above ground or with respect to adjacent elements are involved, the feed pipe system should have good insulating properties and proper design to reduce leakage current to a negligible value. The water flow through each of the cooled elements should be interlocked with the power supplied to prevent tube damage in case of inadequate cooling flow. Refer to tabulated data for minimum resistivity values of the water in the two systems.

It is recommended that the water-cooling system be of the closed type. In tube types such as the A2346F having high heat dissipation per unit area, it is essential that high quality water be utilized to prevent scale formation, corrosion, and excessive electrolysis. The deposition of material (such as an oxide scale) not only restricts water flow but also prevents proper heat transfer from the tube elements to the cooling water. Corrosion and electrolysis can destroy the tube elements, ducts, and fittings. Electrolysis may also be a source of sufficient oxygen to cause an increased rate of deposition. Any one of these conditions can greatly reduce tube life.

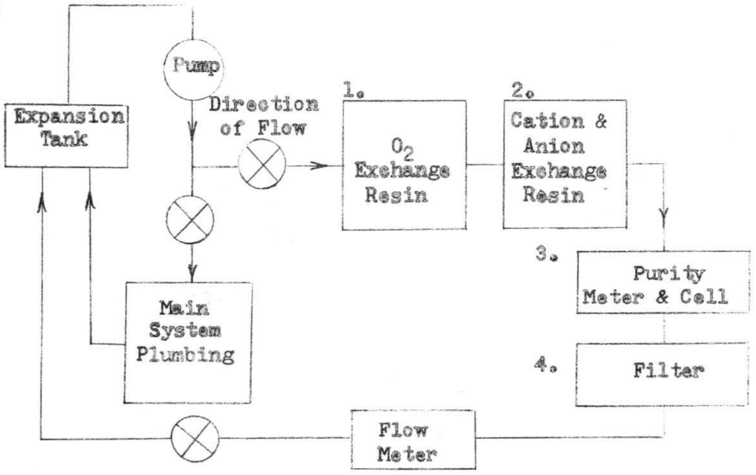
The specific resistivity of the cooling water is only an approximate indication of water quality. Dissolved gases, metals, and other contaminants reduce the resistivity of the water in varying amounts. Some contaminants, such as O_2, have no direct effect while others such as CO_2 greatly reduce the resistivity. However, if the specific resistivity of the water falls below one megohm-cm, it can be assumed that the contaminants are excessive. Also, if the pH of the water is outside the range 6.8 to 7.2, the water contains excessive contaminants.

A suggested method of achieving water of acceptable quality is as follows:

1. Use only distilled water to fill the system. The use of distilled water avoids the introduction of organic or colloidal matter that may exist in de-ionized water.

2. To maintain acceptable quality, continuous regeneration (purification) of the water in the system is necessary. This regeneration can be achieved by passing a portion of the flow through suitable ion exchanger and filters. A recommended regeneration loop is shown in Figure 1. Operation of the regeneration loop should follow the recommendations of the manufacturer of each component with regard to pressure, temperature, and maintenance of the individual components.

Figure 1. DIAGRAM OF A WATER REGENERATION LOOP



Block No.
1. Oxygen absorbent resin
2. Mixed bed demineralizer
3. Resistivity cell (enclosed in system) and meter
4. Sub-micron filter

The above items may be purchased from the Barnstead Still & Sterilizer Company, Boston, Massachusetts.

3. The efficiency and life of the regeneration loop may be improved by retarding the rate of recontamination of the water by foreign matter. Pipe lines should be connected to the water tank below the water level to minimize turbulence and thus to decrease absorption of gases by the water. A further decrease in absorption of gases may be accomplished by introducing a nitrogen blanket above the water in the water tank so as to displace the air.

4. In order to minimize electrolysis, the resistivity of the cooling water should not be less than that specified in the general data.

Proper functioning of the water-cooling system is of the utmost importance. Even a momentary failure of the water flow will damage the A2346F. Infact, without cooling water, the heat of the filament alone is sufficient to cause serious harm. It is, therefore, necessary to provide a method of preventing operation of the tube in case the water supply should fail. This may be done by the use of water-flow circuit breakers or interlocks which open the power supplies when the flow through any element is insufficient or ceases. It is essential to keep the water-flow interlocks in proper adjustment as prescribed by the equipment manufacturer. They should never be set to operate below the recommended level. The water flow must start before application of any voltages and preferably should continue for several seconds after removal of all voltages. The absolute minimum water flow required through the plate, grids, and grid-cathode cooling ducts together with pressure drops is given in the general data. Under no circumstances should the temperature of the water from any outlet exceed 70°C.

A filament starter should be used to raise the filament current gradually in order to limit the high initial surge of current through the filament when the circuit is first closed. This initial value of current should be limited to 2000 amperes and at no time during any subsequent stage of heating should the value of filament current exceed the specified maximum value, (see general data) even momentarily.

For stable operation it is adviseable to maintain the drive pulse at the operating level during the entire duration of the plate voltage pulse. The drive pulse should be initiated sufficiently ahead of the plate pulse, and should remain sufficiently long after the end of the plate pulse to insure this condition. However, the drive pulse length should not exceed the plate pulse length by more than 10%.

When a new circuit is tried or when adjustments are made, the plate voltage should be reduced to approximately one-half the rated value to prevent damage to the tube and associated apparatus. After correct adjustment has been made with the tube operating smoothly and without excessive heating of the cooling water or the ceramic bushings, the plate voltage may be raised in steps to the desired value. Adjustments should be made at each step for optimum operation.

At the higher frequencies, uneven heating of the seals may be encountered because of circuit arrangement. Such effects should be minimized through proper circuit design.

The following "break in" treatment should be given to a new A2346F before it is placed in service or set aside as a spare, or to a A2346F after is has been in prolonged storage. The treatment should preferably be given in the unit the tube is to operate.

Step 1: Make sure that the water-cooling system and protective devices are functioning properly.

Step 2: With no other voltages on tube, apply current to the filament in the normal manner and operate at the specified typical value (See tabulated data) for 15 minutes.

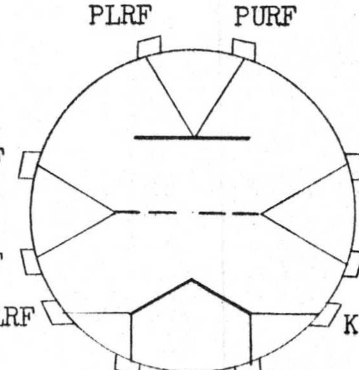
Step 3: Apply approximately 75% normal drive power and operate for 15 minutes.

Step 4: Apply approximately 50% normal plate voltage and operate the tube for several minutes until stable performance is obtained. Raise drive power to normal value.

CAUTION: During this step, it is particularly important that the high-speed electronic protective device be functioning properly to protect against any abnormal condition.

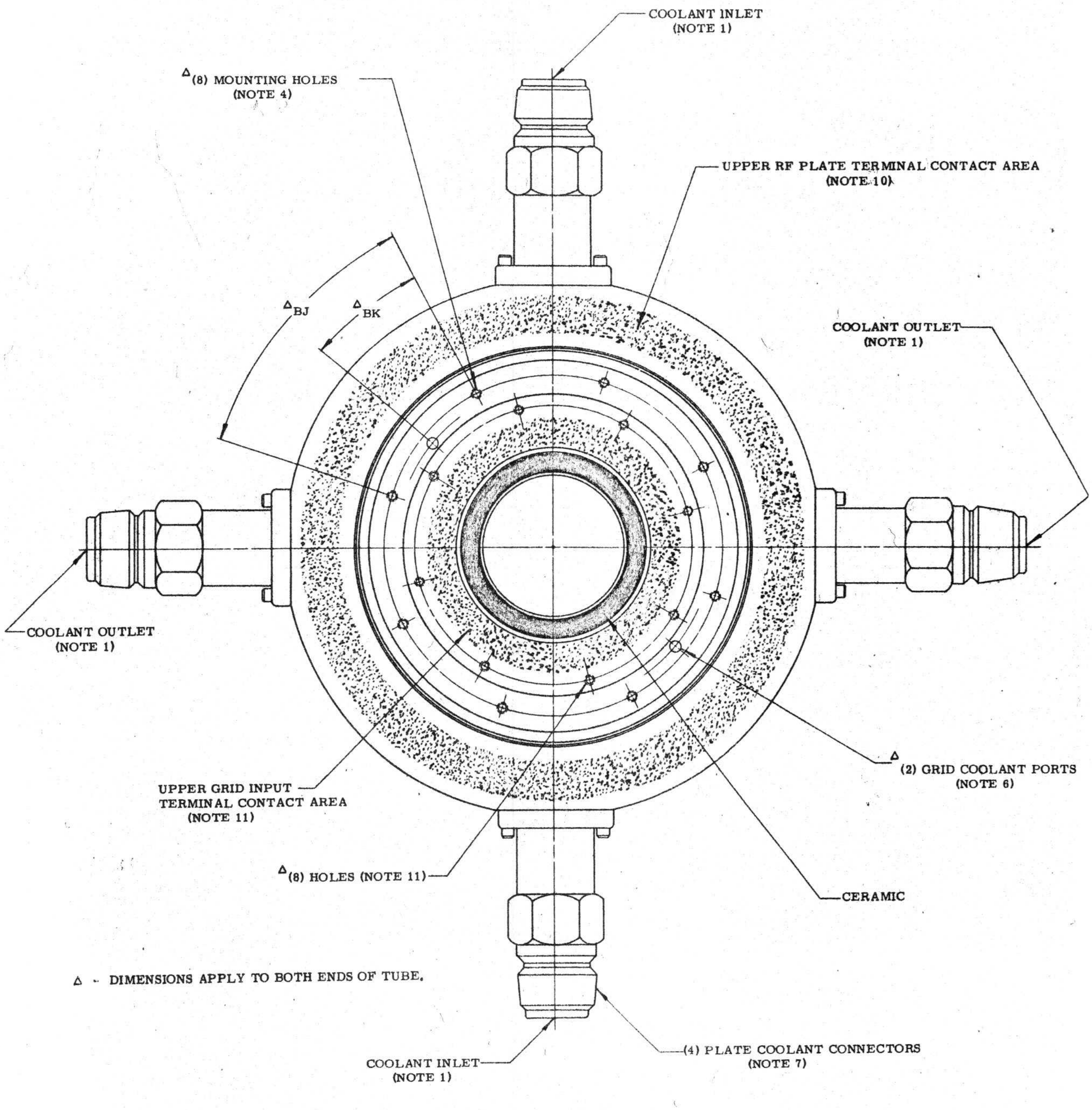
Step 5: Raise the plate voltage in steps if possible until the desired operating condition is achieved.

After giving the A2346F the above treatment and after it is operating normally, it is suggested that the readings of the meters and flow indicators as well as the control settings be logged, especially when the tube is to be set aside as a spare. Then, in the event of an emergency tube change, the tube can be put in service quickly.



FI:	Filament Terminal (inner)
FO:	Filament Terminal (outer)
KURF:	Upper RF Cathode Terminal
KLRF:	Lower RF Cathode Terminal
GUIRF:	Upper RF Grid Input Terminal
GUORF:	Upper RF Grid Output Terminal
GLIRF:	Lower RF Grid Input Terminal
GLORF:	Lower RF Grid Output Terminal
PLRF:	Lower RF Plate Terminal
PURF:	Upper RF Plate Terminal

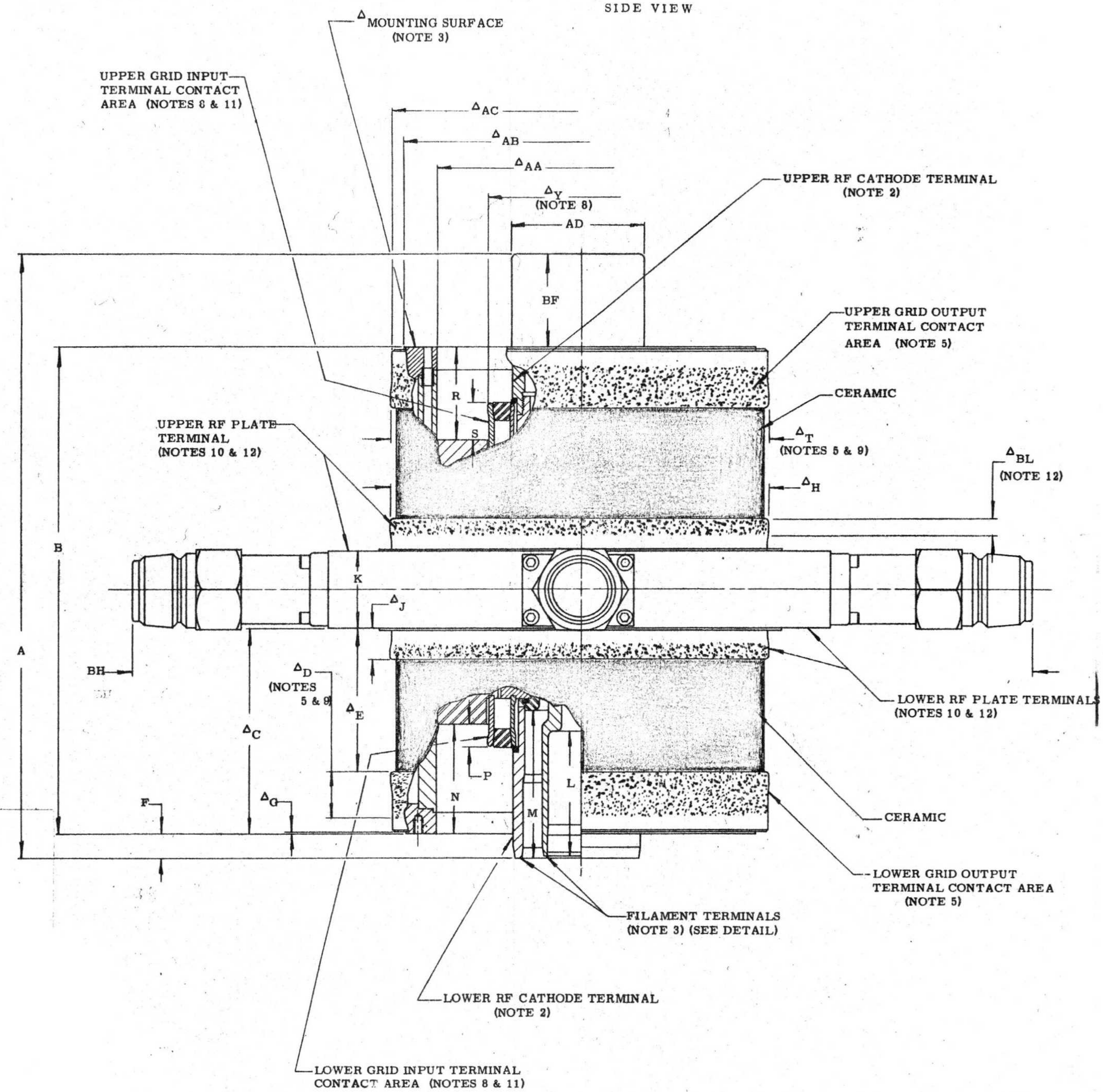
TOP VIEW



Δ - DIMENSIONS APPLY TO BOTH ENDS OF TUBE.

Preliminary and Tentative Data (Cont'd)

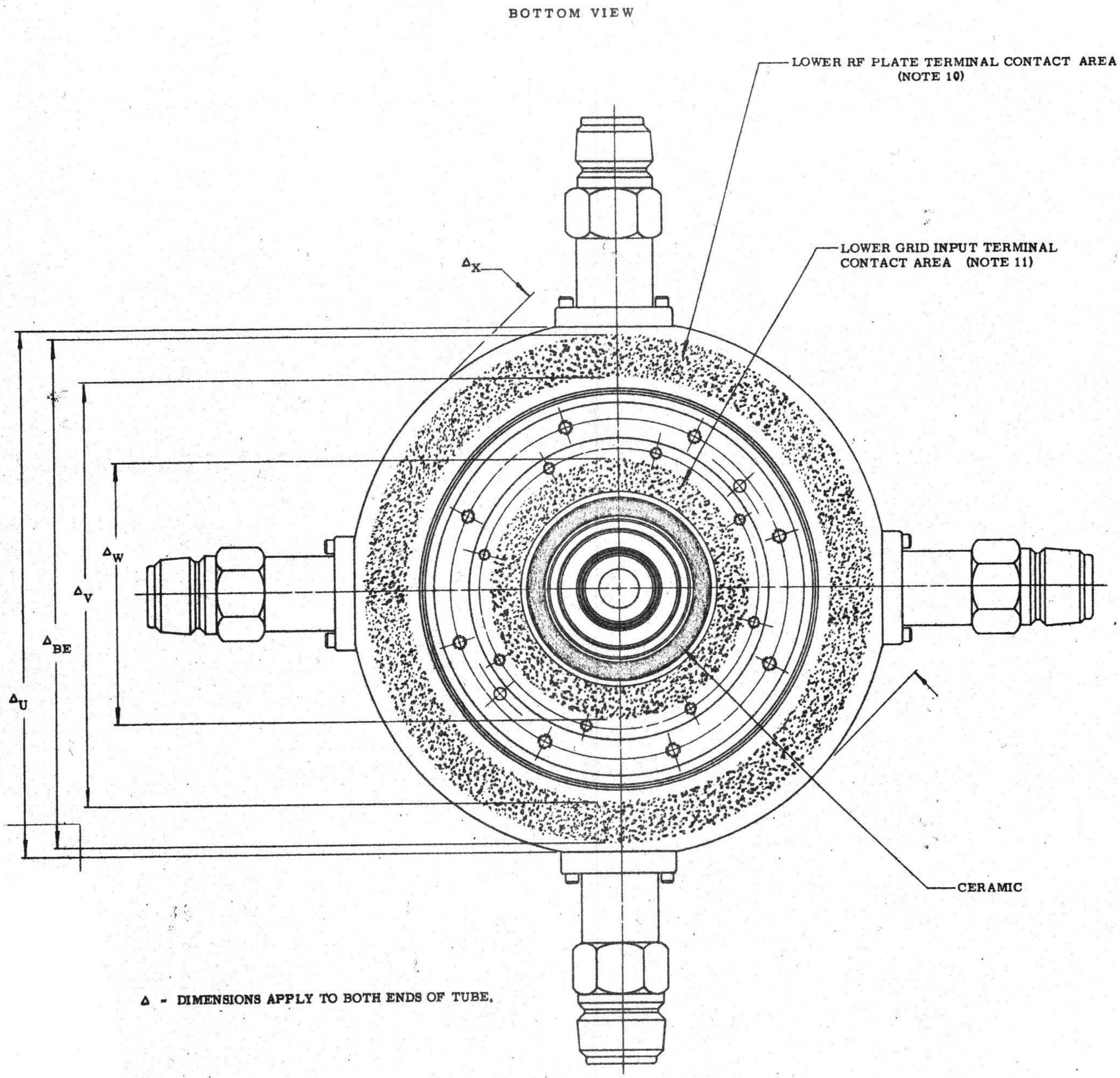
RCA Developmental Type, Dev. No. A2346F



Δ - DIMENSIONS APPLY TO BOTH ENDS OF TUBE.

Preliminary and Tentative Data (Cont'd)

RCA Developmental Type, Dev. No. A2346F

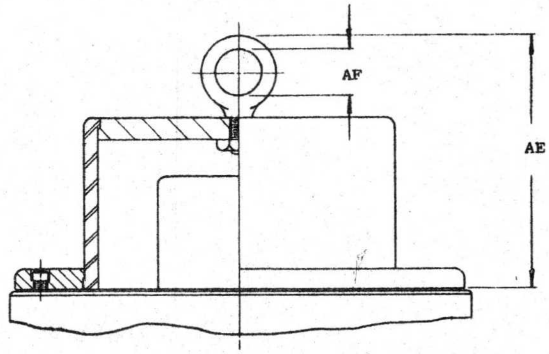


Δ - DIMENSIONS APPLY TO BOTH ENDS OF TUBE.

Date March 29, 1960 ~~PTO-920-19~~

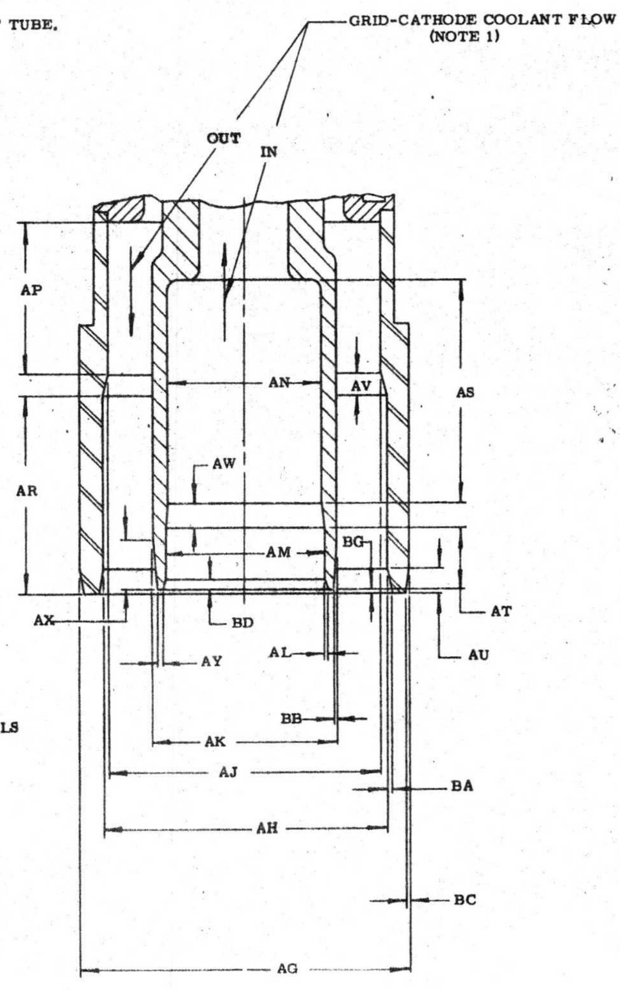
Supersedes 11-21-56 (GIVE DATE)

DETAILS



DETAIL OF LIFTING PLATE
(NOTE 4)

Δ - DIMENSIONS APPLY TO BOTH ENDS OF TUBE.



DETAIL OF FILAMENT TERMINALS

Preliminary and Tentative Data (Cont'd)

TABULATED DIMENSIONS

RCA Developmental Type, Dev. No. A2346F

Dimension	Published Dimension	Notes
A	17.000 Max.	
B	13.500 Max.	
C	5.595 ± 0.090	
D	0.750 Min.	5 & 9
E	3.875 ± 0.090	
F	0.625 ± 0.125	
G	0.250 Max.	
H	10.300 Max. Dia.	
J	0.875 + 0.090 / - 0.030	
K	2.125 + 0.030 / - 0.060	
L	3.375 ± 0.035	
M	4.000 ± 0.035	
N	2.975 ± 0.060	
P	0.610 ± 0.060	8
R	2.575 ± 0.060	
S	1.035 ± 0.060	8
T	10.300 Max. Dia.	5, 9
U	13.675 ± 0.125 Dia.	
V	12.000 Max. Dia.	10
W	6.750 Min. Dia.	11
X	14.000 ± 0.125 Dia.	
Y	4.960 ± 0.060 Dia.	8
AA	7.750 ± 0.125 Dia.	
AB	9.525 ± 0.125 Dia.	
AC	10.120 Min. Dia.	5
AD	3.625 ± 0.030 Dia.	
AE	6.000 Max.	
AF	0.875 Min. Dia.	

Dimension	Published Dimension	Notes
AG	3.62[illegible] [illegible].030 Dia.	
AH	3.125 ± 0.005 Dia.	
AJ	3.002 ± 0.005 Dia.	
AK	2.000 ± 0.030 Dia.	
AL	0.027 Ref.	
AM	1.750 ± 0.005 Dia.	
AN	1.700 ± 0.005 Dia.	
AP	1.650 ± 0.010	
AR	2.100 ± 0.010	
AS	2.500 ± 0.010	
AT	0.625 ± 0.010	
AU	0.277 Ref.	
AV	0.250 Ref.	
AW	0.250 Ref.	
AX	0.500 Ref.	
AY	0.064 Ref.	
BA	0.039 Ref.	
BB	0.034 Ref.	
BC	0.039 Ref.	
BD	0.100 Ref.	
BE	13.400 Min. Dia.	10
BF	2.450 ± 0.125	
BG	0.100 Max.	
BH	24.000 Max. Dia.	
BJ	45° Ref.	
BK	22-1/2° ± 1°	
BL	0.625 Min.	12

Date March 29, 1960

Supersedes PTO-920-19 11-21-56 (GIVE DATE)

Preliminary and Tentative Data (Cont'd)

RCA Developmental Type, Dev. No. A2346F

NOTES

1. The plate and the grid-cathode coolant flows to the tube are directional as noted. Failure to observe correct flow direction may result in inadequate cooling and short tube life.

2. DC filament current must not be permitted to flow in the upper rf cathode terminal. The internal structure of the tube is such that the potential of the upper rf cathode terminal differs from that of the lower rf cathode terminal by the amount of the DC filament voltage. The circuit designer should take care, therefore to avoid an external DC path between these two cathode terminals.

3. The tube should be operated vertically with either end up. The entire weight of the tube should be supported by the rf plate terminal or by either mounting surface. Never support the tube by the filament terminals or by the upper rf cathode terminal. Care should be taken to avoid distortion or damage to the filament terminals by bumping or improperly fitting connectors.

4. The tube may be conveniently handled and moved by means of the lifting plate which may be attached to either mounting surface. The lifting plate should be removed prior to operating the tube. The mounting surface holes are 1/4-20 NC tap x 0.250" minimum depth, equally spaced on an 8.750" diameter bolt circle. Threads to be checked with go, no-go gauges for a Class 1B fit.

5. Along the tapered contact length D, dimension AC will increase from a minimum diameter of 10.150" (average diameter at this point is 10.200") to a maximum diameter at T (10.300") (average diameter at T is 10.250"). The maximum diameter T is at the end toward the ceramic.

6. The grid coolant flow in each end is directional. The direction of flow, in or out, is stamped at each port. The ports are 0.250" ± 0.010" diameters, 180° ± 1/2° apart on an 8.250" diameter circle. The upper grid cooling ports are located on the mounting surface in the quadrant counter-clockwise from each plate cooling water inlet, as viewed from the top of the tube. The lower grid cooling ports are located on the mounting surface in the same quadrant, as viewed from the top of the tube.

7. The plate cooling connectors, located 90° apart, are Hansen Plugs No. 12-T-46. Fittings may be obtained from the Hansen Manufacturing Company, 4031 West 150th Street, Cleveland 11, Ohio.

8. Along the lengths S & P, dimension Y is subjected to a taper that may increase from the minimum to the maximum diameter with the maximum diameter being at the end toward the ceramic.

9. Circuit contacts should be made only over maximum length D (0.750") of the designated upper and lower output terminal contact areas.

10. Contact of the upper and lower rc plate terminals contact areas should not be made at a diameter greater than 13.400" or less than 12.000".

11. Contact of the upper and lower grid input terminals contact areas should not be made at a diameter greater than 6.750". The holes located outside the contact area are 1/4-20 NC tap x 0.250" minimum depth, equally spaced on an 7.250" diameter bolt circle. Threads to be checked with go, no-go gauges for a Class 1B fit.

12. Circuit contacts should be made only over a maximum length BL (0.625") of designated upper and lower rf plate terminals.

Date March 29, 1960

Supersedes PTO-920-19 11-21-56 (GIVE DATE)

T 506-2 3/59

T.P.D.

Preliminary and Tentative Data

RCA Developmental Type, Dev. No. A2346G *

* The number identifies a particular laboratory tube design but the number and identifying data are subject to change. No obligations are assumed as to future manufacture unless otherwise arranged.
¢ Indicates a change. Place next to change item.

INDUSTRIAL TUBE PRODUCTS — UHF TRIODE — SUPER POWER

RCA developmental type A2346G is a ceramic envelope, water cooled, hi mu, super power triode intended for use in pulse power amplifier service at frequencies up to 600 Mc. A useful peak power output of 2.5 megawatts in long pulse service can be obtained with suitable output cavity circuits.

The A2346G features an internal electrode structure consisting of a precisely spaced cylindrical array of 96 identical triode units each employing a thoriated tungsten filament strand to provide high emission, long life and economical operation.

The tube employs double-ended construction with symmetrically placed ceramic insulators and coaxial contact terminals at either end of the cylindrical tube structure. This arrangement permits placement of the active tube elements at the electrical center of a half-wavelength portion of resonant cavity, and allows operation at higher frequencies than are possible with single-ended tubes of comparable power capabilities.

GENERAL DATA

Electrical

Filament, Multistrand Thoriated Tungsten		
Current	6800	typical amperes
	7000	maximum amperes
Initial Surge Starting Current @	Must Never Exceed 2000 Amperes, Even Momentarily	
DC Voltage @ for 6800 Amperes	3.2	minimum volts
	4.5	maximum volts
Minimum Heating Time at Operating Current	60	seconds
Amplification Factor	250	
Direct Interelectrode Capacitances		
Grid to Anode	150	uufd
Grid to Cathode	1500	uufd
Anode to Cathode	1.5	uufd

For further information or application assistance on this developmental type or other RCA tubes, please contact your field representative at the RCA District Office nearest you.

WHitehall 4-2900
Suite 1154
Merchandise Mart Plaza
Chicago 54, Ill.

HUmboldt 5-3900
744 Broad St.
Newark 2, N. J.

RAymond 3-8361
6355 E. Washington Blvd.
Los Angeles 22, Calif.

Preliminary and Tentative Data (Cont'd)

RCA Developmental Type, Dev. No. A2346G

Mechanical

Operating Position	Vertical, Either End Up
Overall Length	17 max. inches
Maximum Diameter Ø	14.2 max. inches
Terminal Connections	See Dimensional Outline
Weight	
Uncrated	190 pounds
Crated	360 pounds

Air Cooling

It is important that the temperature of any external part of the tube not exceed 150°C. In general, forced air cooling of the ceramic bushings will be required if the A2346G is used in a confined space without free circulation of air. Under such conditions, provision should be made for blowing an adequate quantity of air over ceramic bushings to limit their maximum temperature to 150°C.

Water Cooling

Water cooling of the upper and lower grid terminals, grid-cathode structure and the plate is required. The water flow must start before application of any voltages in order to purge the system of bubbles and should continue for several minutes after removal of all voltages. Interlocking of water flow through each of the cooled elements with all power supplies is recommended to prevent tube damage in case of failure of adequate water flow. The use of distilled water is essential.

Water Flow	Absolute Minimum Flow GPM	Typical Flow GPM	Pressure Differential for Typical Flow ## PSI	Maximum Input Gauge Pressure @@ PSIG
To Plate: Total Flow for Two Parallel Input and Output Water Paths	120	150	40 max.	90
To Upper Grid Cooling Course	2	3	20 max.	90
To Lower Grid Cooling Course	2	3	20 max.	90
To Grid-Cathode Cooling Course	30	35	30 max.	60

Resistivity of Water at 25°C	
Plate and Grid Coolant	1 min. megohm-cm
Grid-Cathode Coolant	5 min. megohm-cm

Insulating Ceramic Bushing Temperature	150 max. °C
Water Temperature from Any Outlet	70 max. °C
Metal Surface Temperature	150 max. °C
Minimum Storage Temperature #	-65 min. °C
External Pressure	65 max. PSIG @@

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

Plate Pulsed Amplifier

Maximum Ratings, Absolute Values

For a maximum "on" time $ of 600 useconds in any 8600 usecond interval

	For frequencies up to 605 Mc	
Peak Pulse Plate Supply Voltage	25,000 max.	volts
Peak Pulse Grid-Cathode Bias Voltage	-200 max.	volts
Peak Plate Current from Pulse Supply	300 max.	amperes
Peak Pulse Cathode Current **	600 max.	amperes
Average Plate Dissipation	200,000 max.	watts

Typical Operation

With rectangular waveshape and duty factor ØØ of 0.06

	At 550 Mc	
Peak Pulse Plate Supply Voltage	20,000	volts
Peak Pulse Grid-Cathode Bias Voltage	-150	volts
Peak Plate Current from Pulse Supply	250	amperes
Peak Pulse Cathode Current **	500	amperes
Peak Pulse Driving Power, approximately$$	225,000	watts
Useful Peak Power Output	2,500,000	watts

Θ The filament current should be gradually raised to operating value in not less than 30 seconds.

@ Measured between KLRF and KURF (see Tube Symbol).

ΘΘ Defined as: $u = -\left(\frac{\Delta E_b}{50}\right)$ Where $E_b = E_{b1} - E_{b2}$
E_{b1} at I_b = 10 Amps, E_c = 0 volts
E_{b2} at I_b = 10 Amps, E_c = -50 volts

Ø Measured across corners of plate coolant ports (see Dimensional Outline).

Measured directly across cooled element.

@@ With the gauge located in an area where the maximum pressure external to the gauge is one atmosphere.

Water cooled elements must be free of water before storage or shipment to prevent damage from freezing.

$ "On" time is defined as the sum of the durations of all the individual pulses which occur during the indicated interval. Pulse duration is defined as the time interval between the two points on the pulse at which the instantaneous value is 70% of the peak value.

** Peak pulse cathode current is the total of the peak plate current from pulse supply and the peak rectified grid current.

ØØ Duty factor is the product of pulse duration and repetition rate.

$$ Approximate value at specified frequency. At higher frequencies, more driving power may be necessary due to increased tube and circuit losses. In all cases, however, the driver stage should be designed to provide an excess of power over that indicated under the typical operating conditions to take care of variations in line voltage, in components, and in tube characteristics.

OPERATING CONDITIONS AND DIMENSIONAL OUTLINE

Refer to Tentative Technical Data for type A15156 dated January 20, 1960, with changes as indicated below. All remarks on these pages apply to the A2346G as well. The Tube Symbol, Outline Drawing, Tabulated Dimensions and Anode Contour Modification Ring Drawings are identical for the two types.

The following changes should be made to the A15156 TTD:

Page 6, paragraph 3, last line - 10 seconds should read 10 milliseconds.

Page 12, note 8 - 8.250 X 0.010 should read 8.250 ± 0.010.

Page 13, note 11, last line - class 2B fit should read class 1B fit.

T.P.D.

Preliminary and Tentative Data

RCA Developmental Type, Dev. No. A2346N *

* The number identifies a particular laboratory tube design but the number and identifying data are subject to change. No obligations are assumed as to future manufacture unless otherwise arranged.
¢ Indicates a change. Place next to change item.

RCA developmental type A2346N is a ceramic envelope, water cooled, extremely hi mu, super power triode intended for use in pulse power amplifier service at frequencies up to 605 Mc. A useful peak power output of 5 megawatts in long pulse service can be obtained with suitable output cavity circuits.

The A2346N features an internal electrode structure consisting of a precisely spaced cylindrical array of 96 identical triode units each employing a thoriated tungsten filament strand to provide high emission, long life and economical operation. Minimum rf coupling between the input and output circuits is realized by the use of a double wound grid structure.

The tube employs double-ended construction with symmetrically placed ceramic insulators and coaxial contact terminals at either end of the cylindrical tube structure. This arrangement permits placement of the active tube elements at the electrical center of a half-wavelength portion of a resonant cavity, and allows operation at higher frequencies than are possible with single-ended tubes of comparable power capabilities.

GENERAL DATA

Electrical

Filament, Multistrand Thoriated Tungsten		
Typical Current	6800-7200@	amperes
Maximum Current	7000-7400@	amperes
Initial Surge Starting Current **	Must never exceed 2000 amperes, even momentarily	
DC Voltage ***		
For the typical current	3.6 min.	volts
	4.5 max.	volts
For the maximum current	4.65 max.	volts
Minimum Heating Time at Operating Current	60	seconds

For further information or application assistance on this developmental type or other RCA tubes, please contact your field representative at the RCA District Office nearest you.

WHitehall 4-2900
Suite 1154
Merchandise Mart Plaza
Chicago 54, Ill.

HUmboldt 5-3900
744 Broad St.
Newark 2, N. J.

RAymond 3-8361
6355 E. Washington Blvd.
Los Angeles 22, Calif.

RADIO CORPORATION OF AMERICA
ELECTRON TUBE DIVISION HARRISON, N. J.

T506-1 3/59

Date March 25, 1960
Supersedes Feb 15, 1960 (GIVE DATE)

Electrical (Continued)

Direct Interelectrode Capacitances

Grid to Anode	150	uufd
Grid to Cathode	1600	uufd
Anode to Cathode	Less than 1.0	uufd

Mechanical

Operating Position	Vertical, either end up	
Overall Length	17.0 max.	inches
Maximum Diameter	14.125 max.	inches
Terminal Connections	See Dimensional Outline	
Weight		
Uncrated	175	pounds
Crated	340	pounds

Air Cooling

It is important that the temperature of any external part of the tube not exceed 150°C. In general, forced air cooling of the ceramic bushings and the adjacent contact areas will be required if the tube is used in a confined space without free circulation of air. Under such conditions, provision should be made for blowing an adequate quantity of air across the ceramic bushings and adjacent terminal areas to limit their maximum temperature to 150°C.

Water Cooling

Water cooling of the upper and lower grid terminals, grid-cathode structure and the plate is required. The water flow must start before application of any voltages in order to purge the system of bubbles and should continue for several minutes after removal of all voltages. Interlocking of water flow through each of the cooled elements with all power supplies is recommended to prevent tube damage in case of failure of adequate water flow. The use of distilled water is essential.

Water Flow	Typical Flow GPM	Absolute Minimum Flow GPM	Pressure Differential for Typical Flow # PSI	Maximum Input Gauge Pressure ## PSIG
To Plate: Total Flow for Two Parallel Input and Output Water Paths	160	150	40 max.	90
To Upper Grid Cooling Course	3	2	20 max.	90
To Lower Grid Cooling Course	3	2	20 max.	90
To Grid-Cathode Cooling Course	35	30	30 max.	60

Resistivity of Water at 25°C

Plate and Grid Coolant	1 min.	megohm-cm
Grid-Cathode Coolant	5 min.	megohm-cm

Preliminary and Tentative Data (Cont'd)

RCA Developmental Type, Dev. No. A2346N

Mechanical (Continued)

Insulating Ceramic Bushing Temperature	150 max. °C
Metal Surface Temperature	150 max. °C
Water Temperature from Any Outlet	70 max. °C
Minimum Storage Temperature ###	-65 min. °C
External Gas Pressure	65 max. PSIG ##

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

Plate Pulsed Amplifier

Maximum Ratings, Absolute Values
For a maximum "on" time θ of 2200 microseconds in any 34,000 microsecond interval

	For Frequencies up to 450 Mc.	For Frequencies up to 605 Mc.	
Peak Pulse Plate Supply Voltage θθ	34,000	25,000	max. volts
Peak Pulse Grid-Cathode Bias Voltage θθθ	-150	-150	max. volts
Peak Plate Current from Pulse Supply	300	300	max. amperes
Peak Pulse Cathode Current ∅	600	600	max. amperes
Average Plate Dissipation	300,000	300,000	max. watts

Typical Operation
With rectangular waveshape and duty factor ∅∅ of 0.06

	At 440 Mc.		At 550 Mc.	
Peak Pulse Plate Supply Voltage θθ	33,000	30,000	20,000	volts
Peak Pulse Grid-Cathode Bias Voltage θθθ	-60	-80	-100	volts
Peak Plate Current from Pulse Supply	295	285	250	amperes
Peak Pulse Cathode Current ∅	590	570	500	amperes
Peak Pulse Driving Power	200,000	170,000	225,000	watts
Useful Peak Power Output	5,000,000	4,000,000	2,500,000	watts

Maximum Ratings, Absolute Values
For a maximum "on" time θ of 10,000 microseconds in any 155,000 microsecond interval

	Frequencies up to 450 Mc.	
Peak Pulse Plate Supply Voltage θθ	28,000	max. volts
Peak Pulse Grid-Cathode Bias Voltage θθθ	-150	max. volts
Peak Plate Current from Pulse Supply	250	max. amperes
Peak Pulse Cathode Current ∅	500	max. amperes
Average Plate Dissipation	200,000	max. watts

Typical Operation
With rectangular waveshape and duty factor ∅∅ of 0.06

	At 440 Mc.	
Peak Pulse Plate Supply Voltage θθ	25,000	volts
Peak Pulse Grid-Cathode Bias Voltage θθθ	-50	volts
Peak Plate Current from Pulse Supply	220	amperes
Peak Pulse Cathode Current ∅	440	amperes
Peak Pulse Driving Power	140,000	watts
Useful Peak Power Output	2,500,000	watts

@ The typical and maximum operating filament currents recommended for each tube are specified on a label attached to the outside diameter of the plate terminal of each tube. The specified maximum filament current for each tube is a maximum rating which should not be exceeded, even momentarily, during operation of the tube. The life of the tube can be conserved by operating the filament at the lowest current which will enable the tube to provide the desired power output. Because the filament when operated near the maximum value usually provides emission in excess of any requirements within the tube ratings, the filament current should be reduced to a value that will give adequate but not excessive emission for any particular application. Good regulation of the filament voltage is, in general, economically advantageous from the viewpoint of tube life.

** The filament current should be gradually raised to operating value in not less than 30 seconds.

*** Measured between KLRF and KURF (see Tube Symbol).

Measured directly across cooled element.

With the gauge located in an area where the maximum pressure external to the gauge is one atmosphere.

Water cooled elements must be free of water before storage or shipment to prevent damage from freezing.

θ "On" time is defined as the sum of the durations of all the individual pulses which occur during the indicated interval. Pulse duration is defined as the time interval between the two points on the pulse at which the instantaneous value is 70% of the peak value.

θθ The magnitude of any spike on the plate voltage pulse should not exceed its peak value by more than 400 volts, and the duration of any spike when measured at the peak-value level should not exceed 10% of the maximum "on" time. 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.

θθθ Preferably obtained from a cathode bias resistor.

∅ Peak pulse cathode current is the total of the peak plate current from pulse supply and the peak rectified grid current.

∅∅ Duty factor is the product of pulse duration and repetition rate.

OPERATING CONSIDERATIONS

The maximum ratings in the tabulated data are limiting values above which the serviceability of the A2346N may be impaired from the viewpoint of life and satisfactory performance. Therefore, in order not to exceed these absolute ratings, the equipment designer has the responsibility of determining an average design value below each absolute rating by an amount such that the absolute values will never be exceeded under any normal condition of supply-voltage variation, load variation, or manufacturing variation in the equipment itself. Maximum ratings hold for operation up to 5000 feet. Under most conditions pressurized cavities will be required for operation at the indicated typical voltages to prevent flashover at the tube seals.

Best performance and maximum power output are obtained when the tube is operated at near class B conditions. When bias is used it is recommended that it be obtained from a cathode resistor.

The maximum insulating bushing temperature rating, the maximum metal surface temperature rating, the minimum storage temperature rating, the maximum outlet water temperature, and the maximum gauge pressures for the water inlets are tube ratings and should be observed in the same manner as other ratings.

The serial number which identifies each A2346N is stamped on the name plate located on the outside diameter of the plate terminal. With the exception of the filament current ratings mentioned above, other numbers stamped on external tube surfaces are for manufacturing purposes only.

In transportation, handling and storage of the A2346N, care should be taken to protect the tube from rough handling that would damage the seals or other parts. NEVER ALLOW THE TUBE TO REST ON THE FILAMENT TERMINALS, UPPER RF CATHODE TERMINAL OR THE CERAMICS. (See Dimensional Outline.) The lifting plate is provided for convenience in installing or removing the tube from equipment. After the tube has been seated in the equipment, remove the lifting plate before the tube is placed in operation. Save the lifting plate so that it can be used to remove the tube from the equipment when desired.

It is recommended that the A2346N be tested upon receipt in the equipment in which it is to be used. Recommended "break in" treatment is described later. Before the tube is placed in operation, remove any foreign material adhering to it. After the tube has been tested and before it is placed in storage, the internal ducts should be blown free of water especially if the storage temperature will drop below 0°C (32°F). Care should be taken to prevent any foreign matter from entering the water connections at any time. As a safeguard, it is recommended that during storage the A2346N be completely enclosed in a protective plastic bag, and then sealed in the container in which it was received. When the tube is used under conditions in which the ambient temperature is below 0°C (32°F), precaution should be taken to prevent freezing of the water in the coolant ducts after power has been turned off.

Tube cleanliness is an important consideration. As with other high voltage equipment it is essential that external parts of the A2346N be kept free from accumulated dirt to minimize surface leakage and reduce the possibility of arc-over. Make it a regular practice to remove dirt from the surfaces of the tube at least twice a month, or more frequently if necessary to keep the tube clean. Particular care should be taken to prevent foreign particles from coming in contact with the re-entrant areas at the edge of the ceramic seals. Unless adequately protected, these areas collect dirt rapidly due to electrostatic forces and the nature of the air circulation around the tube.

The mounting used for the A2346N should hold the tube vertically with the upper lifting plate up. The entire weight of the tube should be supported by the upper or lower mounting surfaces. (See Dimensional Outline.) Provision should be made to avoid subjecting the tube to appreciable shock.

Because of the low voltage, high current filament, it is recommended that the filament connectors be kept short to minimize voltage drop. The use of coaxial filament connectors is recommended. The connector for the coaxial terminals of the filament should be of the coil spring, pressure contact type. The filament connectors should make firm, large surface contact. Caution should be exercised when assembling or disassembling the filament connectors, so that the filament terminals are not loosened. The filament connectors should always be rotated clockwise with respect to the tube, both for assembly and disassembly.

Connection to the plate terminal should also be of the spring contact type, bearing on the RF plate terminal contact areas.

When power is applied to the tube, there may be some motion of various parts of the tube and associated circuitry due to thermal expansion. In order that no undue stress is placed on the ceramic-metal seals of the tube, the terminal connectors should be flexible. This can be assured by providing floating concentricity rings to which the flexible contacts are fixed. RF circuit continuity should be provided through the concentricity rings. The connecting leads and water hoses should be installed so that the slack portion does not come close to or approach the body of the tube.

When connecting or disconnecting the water hoses and the electrical connections, it is essential that no undue stress be placed on the seals. The direction of water flow must be as indicated on the dimensional outline for both the plate and grid-cathode coolant flows.

An approximate value of the plate dissipation, which should not exceed the value shown under Maximum Ratings in the tabulated data, may be calculated from the following equation:

$$P_{watts} \text{ equals } n(t_0 - t_1) \times 264$$

in which t_1 is the temperature of the cooling water at the inlet to plate in degrees Centigrade, t_0 is the temperature of the water at the outlet in degrees Centigrade, and n is the number of gallons per minute of total flow for two parallel input and output water paths.

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, that is, after the filament has been operated at the rated typical current for the minimum heating time specified in the tabulated data.

A high-speed, electronic protective device must be used to remove the plate voltage within 10 microseconds in the event of abnormal operation such as internal arcing. The protective device employed to remove the plate voltage in any installation must be approved by an RCA field representative or by the nearest District Sales Office. In addition, the grid drive line should be provided with VSWR protection to remove drive power and plate voltage within 10 milliseconds in the event of abnormal changes in input VSWR during operation.

Circuit return from the plate should be made to the output-circuit-return grid terminals, identified on the tube symbol as GLORF and GUORF. Connection to the output-circuit-return terminals should be made by a system of fingers bearing on the grid output terminal contact areas.

The rated plate voltage of this tube is extremely dangerous to the user. 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 cannot 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 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 water cooling system consists in general of two sources of cooling water, a very high quality system to supply water for the grid-cathode cooling course and a high quality system to supply water to the plate and grid cooling courses. The two systems should be connected to the respective cooling courses through a suitable flexible feed pipe system. Where potentials above ground or with respect to adjacent elements are involved, the feed pipe system should have good insulating properties and proper design to reduce leakage current to a negligible value. The water flow through each of the cooled elements should be interlocked with the power supplies to prevent tube damage in case of inadequate cooling flow. Refer to tabulated data for minimum resistivity values of the water in the two systems.

It is recommended that the water-cooling system be of the closed type. In tube types such as the A2346N having high heat dissipation per unit area, it it essential that high quality water be utilized to prevent scale formation, corrosion, and excessive electrolysis. The deposition of material (such as an oxide scale) not only restricts water flow but also prevents proper heat transfer from the tube elements to the cooling water. Corrosion and electrolysis can destroy the tube elements, ducts, and fittings. Electrolysis may also be a source of sufficient oxygen to cause an increased rate of deposition. Any one of these conditions can greatly reduce tube life.

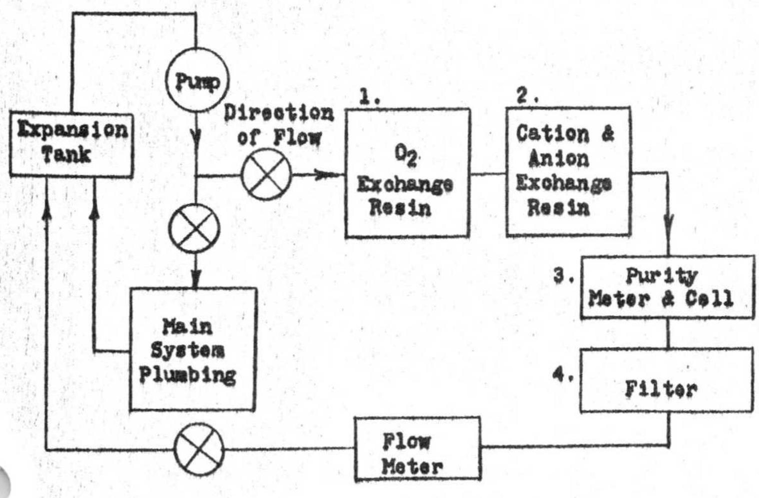
The specific resistivity of the cooling water is only an approximate indication of water quality. Dissolved gases, metals, and other contaminants reduce the resisitivity of the water in varying amounts. Some contaminants, such as O_2, have no direct effect while others such as CO_2 greatly reduce the resistivity. However, if the specific resistivity of the water falls below one megohm-cm, it can be assumed that the contaminants are excessive. Also, if the pH of the water is outside the range 6.8 to 7.2, the water contains excessive contaminants.

A suggested method of achieving water of acceptable quality is as follows:

1. Use only distilled water to fill the system. The use of distilled water avoids the introduction of organic or colloidal matter that may exist in de-ionized water.

2. To maintain acceptable quality, continuous regeneration (purification) of the water in the system is necessary. This regeneration can be achieved by passing a portion of the flow through suitable ion exchanger and filters. A recommended regeneration loop is shown in Figure 1. Operation of the regeneration loop should follow the recommendations of the manufacturer of each component with regard to pressure, temperature, and maintenance of the individual components.

Figure 1. DIAGRAM OF A WATER REGENERATION LOOP



Block No.

1. Oxygen absorbent resin
2. Mixed bed demineralizer
3. Resistivity cell (enclosed in system) and meter
4. Sub-micron filter

The above items may be purchased from the Barnstead Still & Sterilizer Company, Boston, Massachusetts.

3. The efficiency and life of the regeneration loop may be improved by retarding the rate of recontamination of the water by foreign matter. Pipe lines should be connected to the water tank below the water level to minimize turbulence and thus to decrease absorption of gases by the water. A further decrease in absorption of gases may be accomplished by introducing a nitrogen blanket above the water in the water tank so as to displace the air.

4. In order to minimize electrolysis, the resistivity of the cooling water should not be less than that specified in the General Data.

Proper functioning of the water-cooling system is of the utmost importance. Even a momentary failure of the water flow will damage the A2346N. In fact, without cooling water, the heat of the filament alone is sufficient to cause serious harm. It is, therefore, necessary to provide a method of preventing operation of the tube in case the water supply should fail. This may be done by the use of water-flow circuit breakers or interlocks which open the power supplies when the flow through any element is insufficient or ceases. It is essential to keep the water-flow interlocks in proper adjustment as prescribed by the equipment manufacturer. They should never be set to operate below the recommended level. The water flow must start before application of any voltages and preferably should continue for several seconds after removal of all voltages. The absolute minimum water flow required through the plate, grids and grid-cathode cooling ducts together with pressure drops is given in the General Data. Under no circumstances should the temperature of the water from any outlet exceed 70°C.

The typical and maximum operating filament currents may vary from tube to tube as a result of the selection process that assures that filaments with matching characteristics are used in each tube. To facilitate operation at a filament current that will provide adequate, long life emission the typical and maximum operating filament current recommended for each tube is specified on a label attached to the outside diameter of the plate terminal of each tube. (See Dimensional Outline.)

A filament starter should be used to raise the filament current gradually in order to limit the high initial surge of current through the filament when the circuit is first closed. This initial value of current should be limited to 2000 amperes and at no time during any subsequent stage of heating should the value of filament current exceed the specified maximum value, even momentarily.

For stable operation it is adviseable to maintain the drive pulse at the operating level during the entire operation of the plate voltage pulse. The drive pulse should be initiated sufficiently ahead of the plate pulse, and should remain sufficiently long after the end of the plate pulse to insure this condition. However, the drive pulse length should not exceed the plate pulse length by more than 10%.

When a new circuit is tried or when adjustments are made, the plate voltage should be reduced to approximately one-half the rated value to prevent damage to the tube and associated apparatus. After correct adjustment has been made with the tube operating smoothly and without excessive heating of the cooling water or the ceramic bushings, the plate voltage may be raised in steps to the desired value. Adjustments should be made at each step for optimum operation.

At the higher frequencies, uneven heating of the seals may be encountered because of circuit arrangement. Such effects should be minimized through proper circuit design.

The following "break in" treatment should be given to a new A2346N before it is placed in service or set aside as a spare, or to a A2346N after is has been in prolonged service. The treatment should preferably be given in the unit the tube is to operate.

Step 1: Make sure that the water-cooling system and protective devices are functioning properly.

Step 2: With no other voltages on tube, apply current to the filament in the normal manner and operate at the specified typical value for 15 minutes.

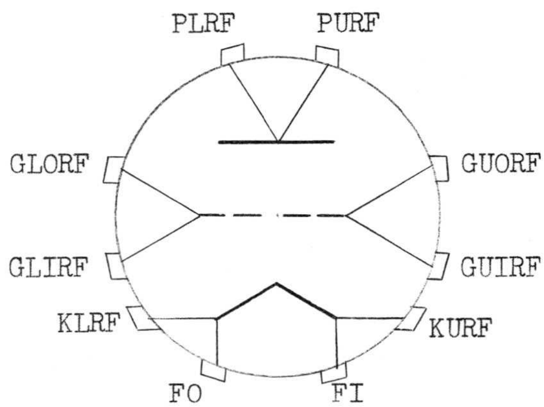
Step 3: Apply approximately 75% normal drive power and operate for 15 minutes.

Step 4: Apply approximately 50% normal plate voltage and operate the tube for several minutes until stable performance is obtained. Raise drive power to normal value.

CAUTION: During this step, it is particularly important that the high-speed electronic protective device be functioning properly to protect against any abnormal condition.

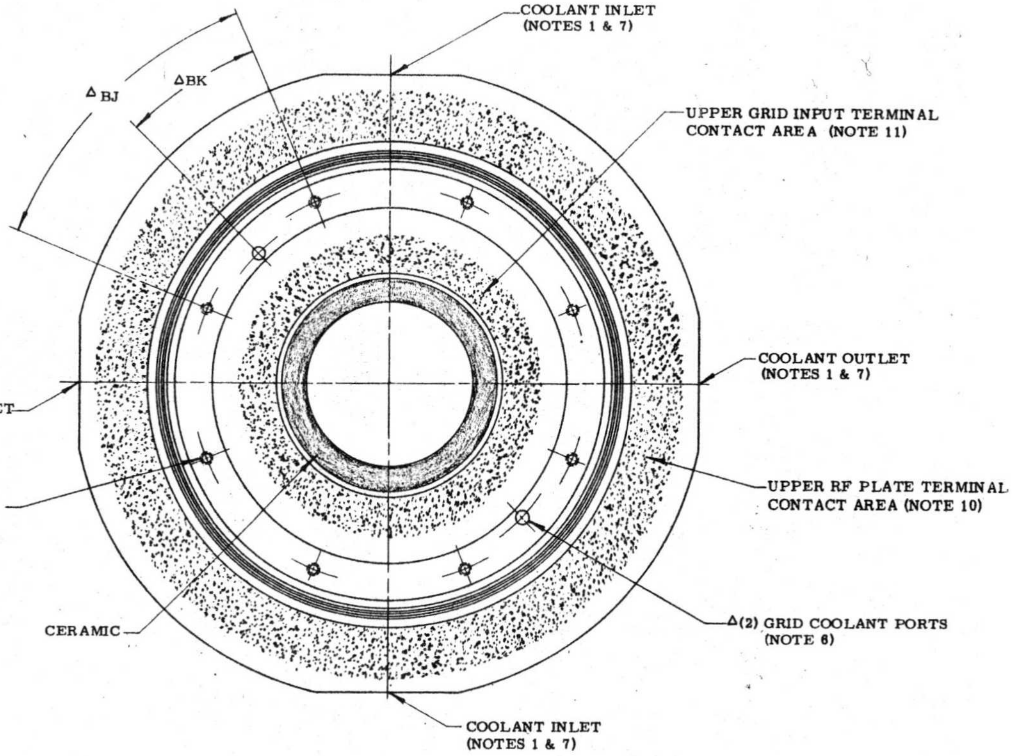
Step 5: Raise the plate voltage in steps if possible until the desired operating condition is achieved.

After giving the A2346N the above treatment and after is is operating normally, it is suggested that the readings of the meters and flow indicators as well as the control settings be logged, especially when the tube is to be set aside as a spare. Then, in the event of an emergency tube change, the tube can be put in service quickly.

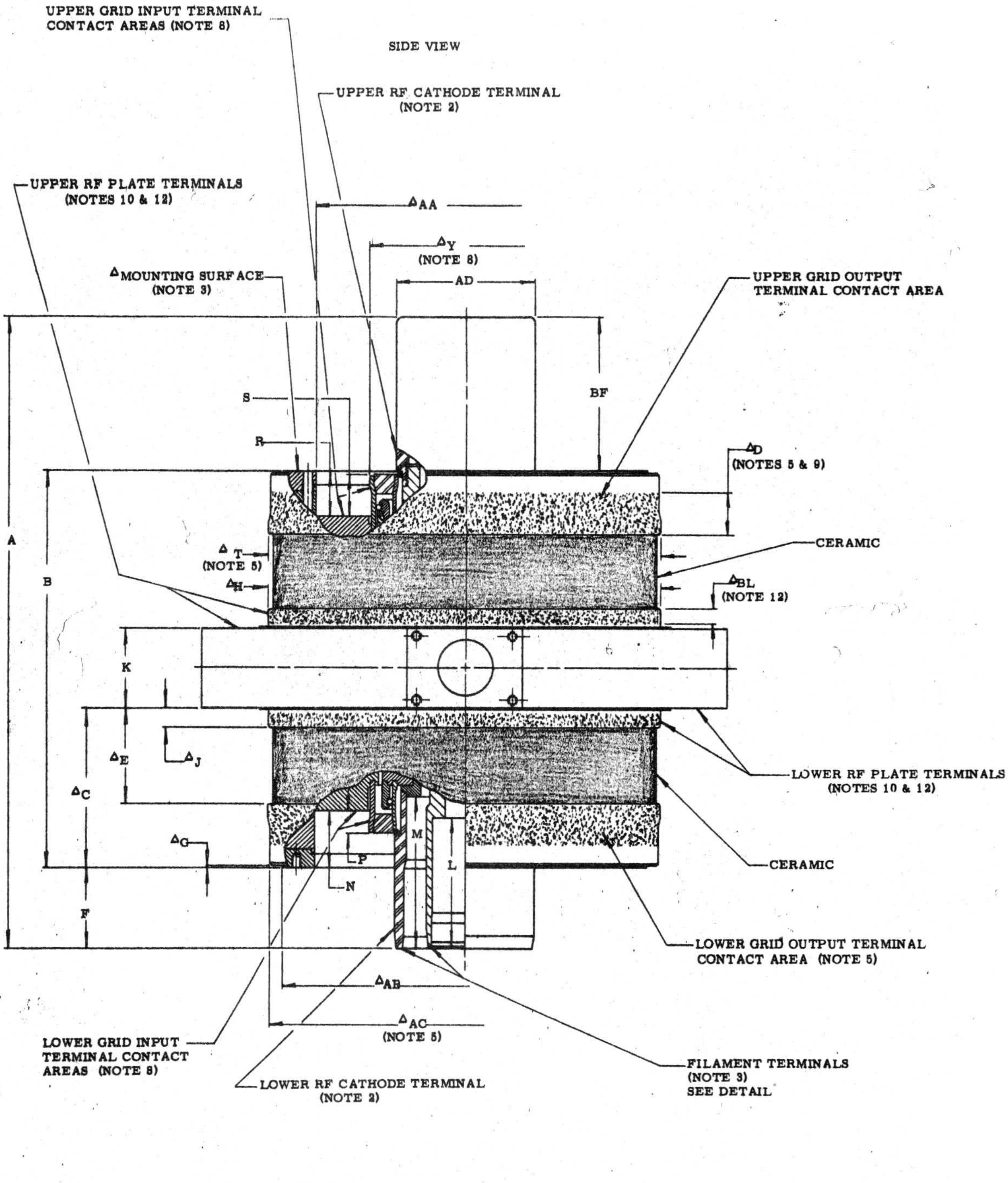


FI:	Filament Terminal (inner)
FO:	Filament Terminal (outer)
KURF:	Upper RF Cathode Terminal
KLRF:	Lower RF Cathode Terminal
GUIRF:	Upper RF Grid Input Terminal
GUORF:	Upper RF Grid Output Terminal
GLIRF:	Lower RF Grid Input Terminal
GLORF:	Lower RF Grid Output Terminal
PLRF:	Lower RF Plate Terminal
PURF:	Upper RF Plate Terminal

TOP VIEW



NOTE; Δ DIMENSIONS & NOTES APPLY TO BOTH ENDS OF TUBE.

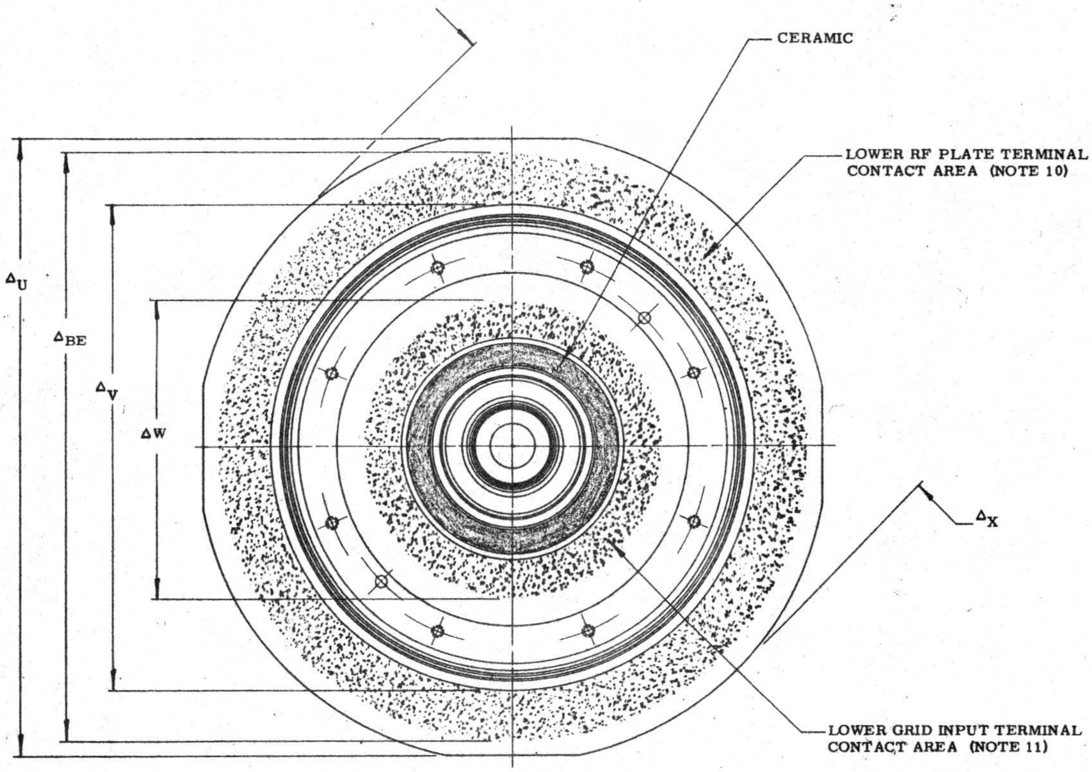


NOTE; Δ DIMENSIONS & NOTES APPLY TO BOTH ENDS OF TUBE.

Preliminary and Tentative Data (Cont'd)

RCA Developmental Type, Dev. No. A2346N

BOTTOM VIEW



NOTE; Δ DIMENSIONS & NOTES APPLY TO BOTH END OF TUBE.

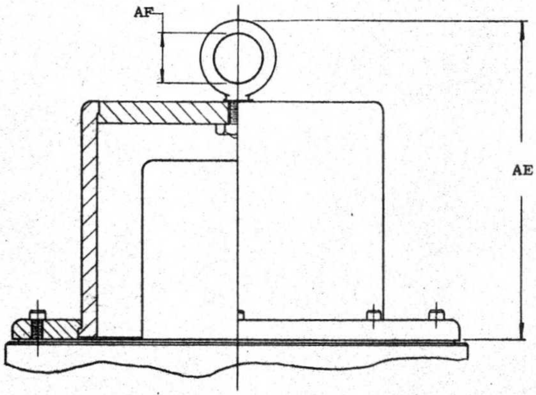
Date March 25, 1960

Supersedes Feb 15, 1960 (GIVE DATE)

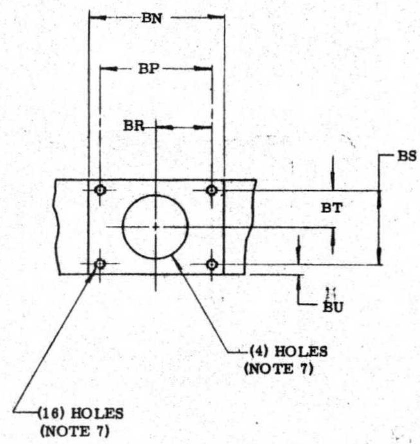
Preliminary and Tentative Data (Cont'd)

RCA Developmental Type, Dev. No. A2346N

DETAILS

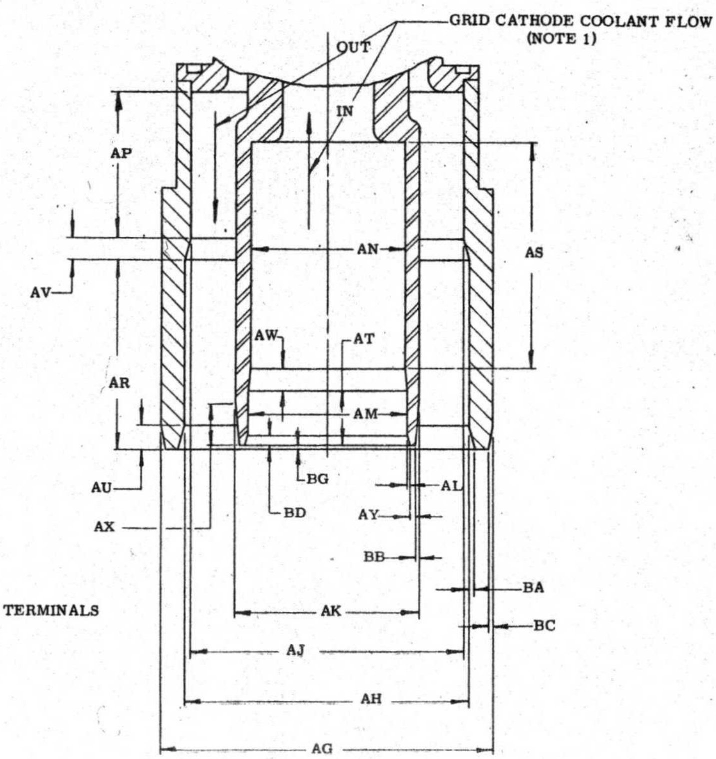


DETAIL OF LIFTING PLATE
(NOTE 4)



DETAIL OF PLATE COOLANT INLET & OUTLET HOLES

NOTE; Δ DIMENSIONS & NOTES APPLY TO BOTH ENDS OF TUBE.



DETAIL OF FILAMENT TERMINALS

Date March 25, 1960

Supersedes Feb 15, 1960 (GIVE DATE)

Preliminary and Tentative Data (Cont'd)

RCA Developmental Type, Dev. No. A2346N

TABULATED DIMENSIONS

Dimensions	Published Dimensions	Notes
A	17.000 Max.	
B	10.650 Max.	
C	4.185 ± .090	
D	0.750 Min.	5, 9
E	2.460 ± 0.090	
F	2.100 ± 0.125	
G	0.250 Max.	
H	10.300 Max.	
J	0.460 $^{+0.060}_{-0.030}$	
K	2.105 ± 0.035	
L	3.375 ± 0.035	
M	4.000 ± 0.035	
N	1.545 ± 0.060	
P	0.610 ± 0.030	8
R	1.140 ± 0.060	
S	1.035 ± 0.030	8
T	10.300 Max. Dia.	5
U	13.675 ± 0.125 Dia.	
V	12.000 Max. Dia.	10
W	6.500 Min. Dia.	11
X	14.000 ± 0.125 Dia.	
Y	4.960 ± 0.060	8
AA	7.750 ± 0.125 Dia.	
AB	9.525 ± 0.125 Dia.	
AC	10.120 Min. Dia.	5
AD	3.625 ± 0.030 Dia.	
AE	7.500 Max.	
AF	0.875 Min. Dia.	
AG	3.625 ± 0.030 Dia.	
AH	3.125 ± 0.005 Dia.	
AJ	3.002 ± 0.005 Dia.	
AK	2.000 ± 0.030 Dia.	
AL	0.027 Ref.	
AM	1.750 ± 0.005 Dia.	
AN	1.700 ± 0.005 Dia.	
AP	1.650 ± 0.010	
AR	2.100 ± 0.010	
AS	2.500 ± 0.010	
AT	0.625 ± 0.010	
AU	0.277 Ref.	
AV	0.250 Ref.	
AW	0.250 Ref.	
AX	0.500 Ref.	
AY	0.064 Ref.	
BA	0.039 Ref.	
BB	0.034 Ref.	
BC	0.039 Ref.	
BD	0.100 Ref.	
BE	13.400 Min. Dia.	10
BF	3.900 ± 0.125	
BG	0.100 Max.	
BJ	45° Ref.	
BK	22-1/2° ± 1°	
BL	0.325 Min.	12
BN	3.000 Ref.	
BP	2.500 ± 0.015	
BR	1.250 ± 0.015	
BS	1.625 ± 0.015	
BT	0.812 ± 0.015	
BU	0.240 ± 0.025	

Preliminary and Tentative Data (Cont'd)

RCA Developmental Type, Dev. No. A2346N

NOTES

1. The plate and the grid-cathode coolant flows in this type are directional as noted. Failure to observe correct flow direction may result in inadequate cooling and short tube life.

2. DC filament current must not be permitted to flow in the upper-rf-cathode terminal. The internal structure of this type is such that potential of the upper-rf-cathode terminal differs from that of the lower-rf-cathode terminal by the amount of the DC filament voltage. The circuit designer should take care, therefore, to avoid an external DC path between these two cathode terminals.

3. This tube should be operated in a vertical position with either end up. The entire weight of the tube should be supported by either mounting surface. Never support the tube by the filament terminals or by the upper-rf-cathode terminal. Care should be taken to avoid distortion or damage to the filament terminals by bumping or improperly fitting connectors. Total indicator run out between terminals will not exceed .100".

4. This tube may be conveniently handled and moved by means of the lifting plate which should be removed prior to operating the tube. The mounting holes are 1/4 - 20 NC x 0.250" minimum depth and are equally spaced on a bolt circle of 8.750" diameter. The thread are Class 1B fit.

5. Along the tapered length, D, dimension AC will increase from a minimum diameter of 10.150" (average diameter at this point is 10.200") to a maximum diameter at dimension, T, of 10.300" (average diameter at this point is 10.250"). The maximum diameter, T, is at the end toward the ceramic.

6. The grid coolant flow in each end is directional. The direction of flow, in or out, is stamped at the side of each port. The ports are 0.250" ± 0.010" diameter and are located 180° ± 1/2° apart on circle of 8.250" diameter. The upper grid coolant ports are located on the mounting surface in the quadrant counter-clockwise from each plate coolant inlet, as viewed from the top of the tube. The lower grid coolant ports are located on the mounting surface in the same quadrant as viewed from the top of the tube.

7. The plate coolant outlet or inlet holes are 1.450" ± 0.030" diameter and located 90° ± 10° apart.

8. Along the lengths S and P, the surfaces are subject to a taper that will increase from a minimum of 4.900" to a maximum diameter, Y, at the end toward the ceramic of 5.020". Dimensions S and P are measured from the metal sealing sleeve not the ceramic.

9. Circuit contacts should be made only over maximum length D (0.750") of the designated upper and lower output terminal contact areas.

10. Contact of the upper and lower rf-plate terminals contact areas should not be made at a diameter greater than 13.400" or less than 12.000".

11. Contact of the upper and lower grid input terminals contact areas should not be made at a diameter greater than 6.500".

12. Circuit contacts should be made only over a maximum length BL (0.325") of the designated upper and lower rf-plate terminals.

Preliminary and Tentative Data

RCA Developmental Type, Dev. No. A15038 *

RCA Developmental Type A15038 is a ceramic-metal envelope, water-cooled, extremely high mu, super-power triode coaxitron amplifier, in which the radio-frequency input and output circuitry, high-voltage blocking circuit, and the grid-controlled electronic structure is integrated within a common vacuum envelope. This tube is especially suited for use as a broadband amplifier in long-range search radar applications, where electronic pulse-to-pulse frequency agility is important, and broadband multi-channel communications applications.

In short-pulse service with a pulse duration of 30 microseconds and a duty factor of 0.01, the A15038 is operable over the 385 to 465 Mcs range and has an exceptionally uniform response over the 400 to 450 Mcs portion of the frequency spectrum with a power output capability in excess of 5 megawatts.

The A15038 coaxitron employs integral radio-frequency input and output circuits. This novel feature minimizes the electrical energy storage in the radio-frequency circuits and maximizes the bandwidth of operation while eliminating the need for any radio frequency tuning mechanisms. The A15038 coaxitron, with its idealized circuits tailored to match the internal electronics of the tube, preserves the inherent broadband capabilities of the grid-controlled interaction system of the basic tube structure.

Other noteworthy features of the A15038 coaxitron include: A low-temperature, matrix-oxide filamentary cathode to provide high emission, long-life and economical operation; a unique, integral, vacuum-insulated dc-voltage blocking circuit for the plate voltage; a coaxial-to-wave guide output transition and associated ceramic-cylinder output window which inserts into a standard size waveguide; a standard size coaxial RF input fitting; an internally grounded grid; and other features, all designed to provide greater power output, broader bandwidth and greater reliability than existing tube-circuit combinations.

For further information or application assistance on this developmental type or other RCA tubes, please contact your field representative at the RCA District Office nearest you.

WHitehall 4-2900	HUmboldt 5-3900	RAymond 3-8361
Suite 1154		
Merchandise Mart Plaza	744 Broad St.	6801 E. Washington Blvd.
Chicago 54, Ill.	Newark 2, N.J.	Los Angeles 22, Calif.

RADIO CORPORATION OF AMERICA
ELECTRON TUBE DIVISION HARRISON, N. J.

Date Oct 3, 1961
Supersedes Aug 8, 1958 (GIVE DATE)

T 506-1 1/62

Preliminary and Tentative Data (Cont'd)

RCA Developmental Type, Dev. No. A-15038

GENERAL DATA

Electrical

Filamentary Cathode, Multistrand, Matrix-Oxide

Typical Current (DC)	1800	amperes
Maximum Current (DC)	2000 **	amperes
Voltage (DC) @		
For the typical current	1.50	volts
Initial Surge Starting Current ***	Must never exceed 2000 even momentarily.	amperes
Minimum Heating Time at Operating Current	60	seconds
Cold and/or Hot Resistance (Approx.)	0.0008	ohms

Getter Ion High Vacuum Pump (See Sheet 10)

Voltage	3500 max.	volts
Current	0.005 max.	amperes

Direct Interelectrode Capacitance

Grid to Anode	220	uufd

Mechanical

Operating Position	Vertical, either end up	
Overall Length	53.750 max.	inches
Overall Diameter	20.025 max.	inches
Terminal Connections	See Dimensional Outline	
Weight (Approximate)		
Uncrated	400	lbs.

Liquid Cooling

Liquid cooling of the grid-cathode structure, lower filament structure and the plate is required. The coolant flow must start before the application of any voltages in order to purge the system of bubbles and should continue for several minutes after the removal of all voltages. Interlocking of coolant flow through each of the cooled elements with all power supplies is recommended to prevent tube damage in case of failure of adequate coolant flow. If water is used as a coolant, it is essential to use distilled water.

The coolant flow through each of the coolant courses is directional. The flow direction of some courses is determined by the position of the output transition (up or down). Near each coolant fitting is a tag indicating the direction of flow for that fitting with the tube in either position. Only the directional marking properly orientated should be observed. Example: In

ono

Water Flow

	Typical Flow GPM	Absolute Minimum Flow GPM	Pressure Differential for Typical Flow # PSI	Maximum Input Gauge Pressure ## PSIG
To Plate: Total Flow for Two Parrallel Input and Output Water Paths				
For Plate Dissipations up to 50 KW ###	40	35	45 max.	60
To Grid-Cathode Cooling Course ###	20	15	15 max.	60
To Lower Filament Cooling Course	5	3	15 max.	60
Min. Resistivity of Water at 25°C			1 megohm-cm	

Insulating Ceramic Bushing Temperature	150 max.	°C
Metal Surface Temperature	150 max.	°C
Water Temperature from Any Outlet	70 max.	°C
Minimum Storage Temperature ####	-65	°C

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

Frequency Range of Operation .... 385-465 Mc

The A15038 coaxitron will operate throughout the above range of frequencies as a pass-band amplifier without resorting to mechanical adjustment of the input or output circuitry associated with the tube.

Plate and Grid Pulsed Amplifier

Proposed Maximum Ratings, Absolute Values
For a maximum "on" time of 35 microseconds in any 3000 microsecond interval. θ

Peak Positive Pulse Plate Supply Voltage θθ	30,000 max.	volts
Peak Plate Current from Pulse Supply	700 max.	amperes
Average Plate Dissipation	50,000 max.	watts

Proposed Typical Operation
With rectangular waveshape and duty factor of 0.008. ØØ

Peak Positive-Pulse Plate Supply Voltage ØØ	22,000	volts
Peak Plate Current from Pulse Supply	450	amperes
Peak Pulse Driving Power (Approx.)	300,000	watts
Useful Peak Power Output	5,000,000 min.	watts

NOTES

@ Voltage measured between FO and FI (See Terminal Connections Diagram).

** The maximum filament current is a maximum rating which should not be exceeded, even momentarily, during operation of the tube. The life of the tube can be conserved by operating the filament at the lowest current which will enable

Notes (Cont'd)
the tube to provide the desired power output. Because the filament, when operated near the maximum value, usually provides emission in excess of any requirements within the tube ratings, the filament current should be reduced to a value that will give adequate but not excessive emission for any particular application. Good regulation of the filament voltage is, in general, economically advantageous from the viewpoint of tube life.

*** The filament current should be gradually raised to operating value in not less than 30 seconds.

Measured directly across cooled element.

With the gauge located in an area where the maximum pressure external to the gauge is one atmosphere.

Series flow through these coolant paths is permissible.

Water cooled elements must be free of water before storage or shipment to prevent damage from freezing.

ØØ Duty factor is the product of pulse duration and repetition rate.

ʘ "On" time is defined as the sum of the durations of all the individual pulses which occur during the indicated interval. Pulse duration is defined as the time interval between the two points at which the instantaneous value is 70% of the peak value.

ʘʘ The magnitude of any spike on the plate voltage pulse should not exceed its peak value by more than 4000 volts, and the duration of any spike when measured at the peak-value level should not exceed 10% of the maximum "on" time. The peak value is defined as the maximum value of a smooth curve through the average of the fluctuations over the top of the pulse.

CHARACTERISTIC RANGE VALUES FOR EQUIPMENT DESIGN

	Note	Min.	Max.	
1. Filament Voltage	1,2	1.30	1.70	volts
2. Filament Voltage	2,3	-	1.8	volts

Note 1: With 1800 Amperes dc filament current.
Note 2: Voltage measured between FI and FO (See Terminal Connections Diagram).
Note 3: With 2000 Amperes dc filament current.

GENERAL CONSIDERATIONS

Ratings

The maximum ratings in the tabulated data are limiting values above which the serviceability of the A15038 may be impaired from the viewpoint of life and satisfactory performance. Therefore, in order not to exceed those absolute ratings, the equipment designer has the responsibility of determining an average design value below each absolute rating by an amount such that the absolute values will never be exceeded under any normal condition of supply-voltage variation, load variation, or manufacturing variation in the equipment itself. Maximum ratings hold for operation up to 5000 feet.

The maximum ceramic insulator temperature rating, the maximum metal surface temperature, the minimum storage temperature rating, the maximum outlet water temperature, and the maximum pressures for the water inlets are tube ratings and should be observed in the same manner as other ratings.

Identification

The serial number which identifies each A15038 should be used in any correspondence concerning the tube. It is printed on the name tag located as indicated on the Dimensional Outline. Other numbers stamped on the external tube surfaces are for manufacturing purposes only.

Handling

In transportation, handling, and storage of the A15038 care should be taken to protect the tube from rough handling that would damage the seals or other parts. Rest the tube only on the mounting surface (See Dimensional Outline); lift the tube only by using the holes provided in the mounting surface.

Cleaning

It is recommended that the A15038 be tested upon receipt in the equipment in which it is to be used. Recommended "break in" treatment is described later. Before the tube is placed in operation, remove any foreign material adhering to it. After the tube has been tested and before it is placed in storage, the internal ducts should be blown free of coolant especially if the storage temperature should drop below 0°C (32°F). Care should be taken to prevent any foreign matter from entering the coolant connection at any time. As a safeguard, it is recommended that during storage the A15038 be completely enclosed in a protective plastic bag, and then sealed in the container in which it was received. When the tube is used under conditions in which the ambient temperature is below 0°C (32°F), precaution should be taken to prevent freezing of the coolant in the coolant ducts after power has been turned off.

Tube cleanliness is an important consideration. As with other high voltage equipment it is essential that external parts of the A15038 be kept free from accumulated dirt to minimize surface leakage and reduce the possibility of arc-over. Make it a regular practice to remove dirt from the surfaces of the tube at least twice a month, or more frequently if necessary to keep the tube clean. Particular care should be taken to prevent foreign particles from coming in contact with the re-entrant areas at the edge of the output ceramic seals. Unless adequately protected, these areas collect dirt rapidly due to electrostatic forces and the nature of the air circulation around the tube.

MECHANICAL CONSIDERATIONS

Mounting

The mounting used for the A15038 should hold the tube vertically with either end up. The entire weight of the tube should be supported by the mounting surface (See Dimensional Outline). Provision should be made to avoid subjecting the tube to appreciable shock.

When connecting or disconnecting the water hoses and the electrical connections, it is essential that no undue stress be placed on the ceramic seals. The direction of coolant flow must be as indicated on the dimensional outline for the plate and grid-cathode coolant flows.

It is important that KO and KI (See Terminal Connection Diagram) NOT be connected together electrically by external fixtures. For example, if KO is grounded, KI must be insulated from ground to avoid electrically short circuiting the filament supply.

COOLING CONSIDERATIONS

Water System

The water cooling system consists in general of a high quality system to supply water for the grid-cathode coolant course, the lower filament coolant course and the plate coolant course. The water system should be connected to the respective cooling courses through a suitable flexible feed pipe system. Where potentials above ground or with respect to adjacent elements are involved, the pipe system should have good insulating properties and proper design to reduce leakage current to a negligible value. The water flow through each of the cooled elements should be interlocked with the power supplies to prevent tube damage in case of inadequate cooling flow. Refer to tabulated data for minimum resistivity values of the water.

It is recommended that the water-cooling system be of the closed type. In tube types such as the A15038 having high heat dissipation per unit area, it is essential that high quality water be utilized to prevent scale formation, corrosion and excessive electrolysis. The deposition of material (such as an oxide scale) not only restricts water flow but also prevents proper heat transfer from the tube elements to the cooling water. Corrosion and electrolysis can destroy the tube elements, ducts, and fittings. Electrolysis may also be a source of sufficient oxygen to cause an increased rate of deposition. Any one of these conditions can greatly reduce tube life.

The specific resistivity of the cooling water is only an approximate indication of water quality. Dissolved gases, metals, and other contaminants reduce the resistivity of the water in varying amounts. Some contaminants, such as O_2, have no direct effect while others such as CO_2 greatly reduce the resistivity. However, if the specific resistivity of the water falls below one megohm-cm, it can be assumed that the contaminants are excessive. Also, if the pH of the water is outside the range 6.8 to 7.2, the water contains excessive contaminants.

Preliminary and Tentative Data (Cont'd)

RCA Developmental Type, Dev. No. A-15038

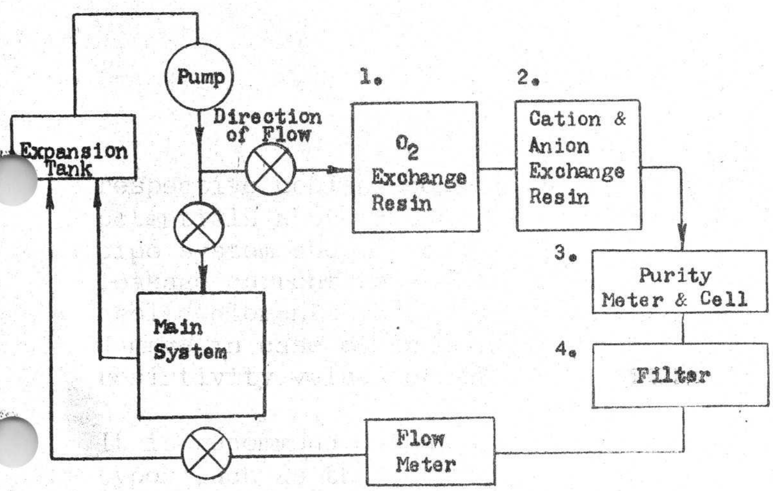
COOLING CONSIDERATIONS (Cont'd)

A suggested method of achieving water of acceptable quality is as follows:

1. Use only distilled water to fill the system. The use of distilled water avoids the introduction of organic or colloidal matter that may exist in de-ionized water.

2. To maintain acceptable quality, continuous regeneration (purification) of the water system is necessary. This regeneration can be achieved by passing a portion of the flow through suitable ion exchanger and filters. A recommended regeneration loop is shown in Figure 1. Operation of the regeneration loop should follow the recommendations of the manufacturer of each component with regard to pressure, temperature and maintenance of the individual components.

Figure 1. DIAGRAM OF A WATER REGENERATION LOOP



Block No.

1. Oxygen obsorbent resin
2. Mixed bed demineralizer
3. Resistivity cell (enclosed in system) and meter
4. Sub-micron filter

The above items may be purchased from the Barnstead Still & Sterilizer Company, Boston, Massachusetts.

3. The efficiency and life of the regeneration loop may be improved by retarding the rate of recontamination of the water by foreign matter. Pipe lines should be connected to the water tank below the water level to minimize turbulence and thus to decrease absorption of gases by the water. A further decrease in absorption of gases may be accomplished by introducing a nitrogen blanket above the water in the water tank so as to displace the air.

4. In order to minimize electrolysis, the resistivity of the cooling water should not be less than that specified in the general data.

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Precautions

Proper functioning of the water-cooling system is of the utmost importance. Even a momentary failure of the water flow will damage the A15038. In fact, without cooling water, the heat of the filament alone is sufficient to cause serious harm. It is, therefore, necessary to provide a method of preventing operation of the tube in case the water supply should fail. This may be done by the use of water-flow circuit breakers or interlocks which open the power supplies when the flow through any element is insufficient or ceases. It is essential to keep the water-flow interlocks in proper adjustment as prescribed by the equipment manufacturer. They should never be set to operate below the recommended level. The water flow must start before application of any voltages and preferably should continue for several seconds after removal of all voltages. The absolute minimum water flow required through the plate, grid-cathode and lower filament cooling ducts courses together with pressure drops is given in the General Data. Under no circumstances should the temperature of the water from any outlet exceed 70°C.

ELECTRICAL CONSIDERATIONS

Plate Dissipation Calculation

An approximate value of the plate dissipation, which should not exceed the value shown under Maximum Ratings in the tabulated data, may be calculated from the following equation

$$P_{watts} \text{ equals } n(t_0 - t_1) \times 264$$

in which t_1 is the temperature of the cooling water at the inlet to plate in degrees Centigrade, t_0 is the temperature of the water at the outlet in degrees Centigrade, and n is the number of gallons per minute of total flow for two parallel input and output water paths.

In the above equation, the values for t_0 and t_1 are read on thermometers installed in the pipe lines as close to the tube as possible.

Safety Precautions

The rated plate voltage of this tube is extremely dangerous to the user. 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 cannot 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 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.

Protective Circuits

A high-speed electronic protection system must be considered for pulse lengths in excess of 10 microseconds to remove the plate voltage from the A15038 in the event of abnormal operation such as internal arcing. In many practical cases, however, this protection circuit will not be required for pulse lengths in excess of 10 microseconds. When the plate modulation system passes the tin-foil test described below simple interruption of the modulator trigger following the occurrance of a fault will be adequate and the use of a high-speed electronic protection system will be unnecessary. In any event, this protection system is used in addition to the usual circuit breakers which alone do not provide adequate protection, especially when the plate modulation system is capable of delivering considerable energy into a short circuit.

A test of the effectiveness of the protection device or of the need for such a device may be made as follows: Disconnect the plate lead from the A15038. Fasten to the "disconnected" plate lead from the modulation system a small sheet (approximately 2" x 2") of thin alumimum foil, such as ordinary household foil. Then discharge the full rated voltage of the plate modulation system by bringing a grounding rod slowly up to the piece of metal foil. The protective device is functioning properly or no high-speed electronic protective device is needed when the discharge of the plate modulation system produces not more than a single pinhole in the foil attached to the plate modulation system lead.

In addition to the above described protection systems, the grid drive line should also be provided with VSWR protection to remove drive power and plate voltage within 10 milliseconds in the event of abnormal changes in input VSWR during operation.

A time delay relay should be provided in the plate supply circuit and the rf drive circuit to prevent application of voltage until the filament has reached its normal operating temperature. (See Minimum Heating Time in General Data.)

RCA Super Power Tube Application Engineering should be consulted in all cases where consideration is being given to the use of high-speed electronic fault protection devices and their application.

Filaments

The matrix-oxide filament in the A15038 is of the multistrand type. A filament starter should be used to raise the filament current gradually in order to limit the high initial surge of current through the filament when the circuit is first closed. This initial value of current should be limited to 2000 amperes and at no time during any subsequent stage of heating should the value of filament current exceed the specified maximum value, (See General Data), even momentarily.

During long or frequent standby periods, the A15038 may be operated at decreased filament voltage to conserve life. It is recommended that the filament current be reduced to 80% of normal during standby periods up to 2 hours. For longer periods, the filament power should be turned off.

Getter Ion High Vacuum Pump

In order to maintain an extremely clean, high vacuum in the tube under all conditions, and to permit continuous monitoring of the internal tube gas current, a getter ion high vacuum pump (See Dimensional Outline) is permanently attached to the tube. This pump takes gas molecules and atoms out of circulation by the formation of chemically stable compounds and ion burial. This action is accomplished by the application of a suitable electric potential and permanent magnetic field to the getter ion pump. The pump power supply should provide adequate metering to permit monitoring of gas currents from several microamperes to several milliamperes.

Driver

The value of driver power output given under Typical Conditions represents approximately the actual driving power required in the specified frequency band. In all cases, however, the driver stage should be designed to provide an excess of power over that indicated under the Typical Operating Conditions to take care of variations in line voltage, in components, in initial tube characteristics, in tube characteristics during life, and transmission line mismatches.

Break-In Procedure

The following "break-in" treatment should be given to a new A15038 before it is placed in service or set aside as a spare, or to an A15038 after it has been in prolonged storage. This treatment preferably should be given in the unit in which the tube is to operate.

Step 1: Make sure that the water-cooling system and protective devices are functioning properly.

Step 2: With no other voltages on tube, apply current to the filament in the normal manner and operate at the specified typical value (See Tabulated Data) for 15 minutes.

Step 3: Apply approximately 75% normal drive power and operate for 15 minutes.

Step 4: Apply approximately 50% normal plate voltage and operate the tube for several minutes until stable performance is obtained. Raise drive power to normal value.

CAUTION: During this step, it is particularly important that the high-speed electronic protective device be functioning properly to protect against any abnormal condition.

Step 5: Raise the plate voltage in steps if possible until the desired operating condition is achieved.

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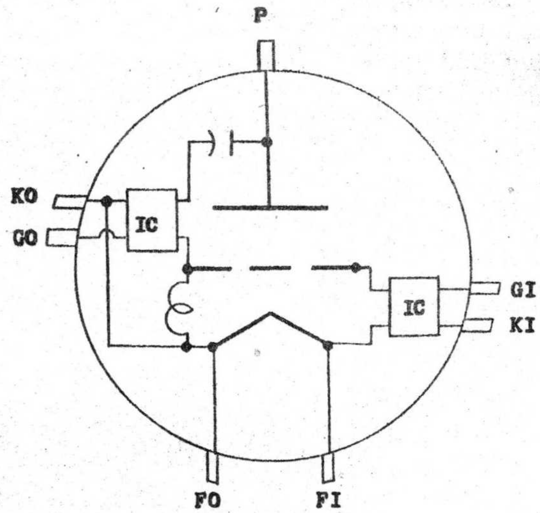
Break-In Procedure (Cont'd)

NOTE: It is pertinent to note that an initial surge of pressure as indicated by the ion pump is normal when breaking in a new tube. Also, the ion pump voltage should be applied prior to filament voltage.

After giving the A15038 the above treatment and after it is operating normally, it is suggested that the readings of the meters and flow indicators as well as the control settings be logged, especially when the tube is to be set aside as a spare. Then, in the event of an emergency tube change, the tube can be put in service quickly.

Preliminary and Tentative Data (Cont'd)

RCA Developmental Type, Dev. No. A-15038



TERMINAL CONNECTIONS DIAGRAM

FI	Inner Filament Terminal
FO	Outer Filament Terminal
GI	RF Grid Input Terminal
GO	RF Grid Output Terminal
KI	RF Cathode Input Terminal
KO	RF Cathode Output Terminal
P	DC Plate Terminal
IC	Integral RF Circuits

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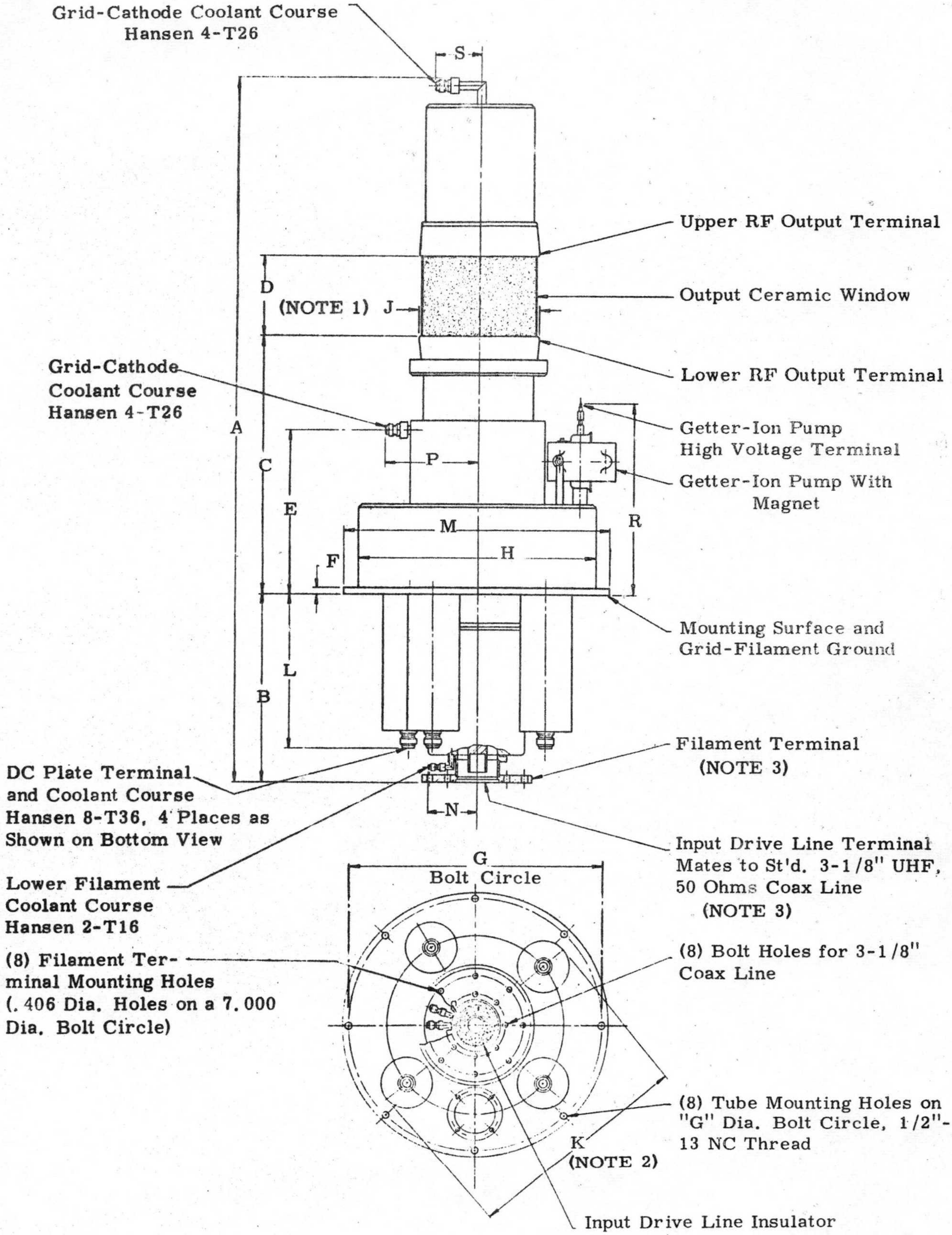
Preliminary and Tentative Data (Cont'd)

RCA Developmental Type, Dev. No. A-15038



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Dimensions are in inches

Dimension	Published Dimension	Manufacturing Dimension	Notes
A	53.750 Max.		
B	15.500 Max.		
C	18.400 ± 0.125		
D	8.625 +0.030 -0.060		
E	12.125 Ref.		
F	0.450 ± 0.025		
G	18.750 ± 0.025 Dia.		
H	17.325 ± 0.060 Dia.		
J	8.620 ± 0.100 Dia.		1
K	17.250 Max. Dia.		2
L	11.250 Max.		
M	20.000 ± 0.025 Dia.		
N	4.000 Ref.		
P	7.000 Ref.		
R	14.125 Ref.		
S	3.250 Ref.		

NOTES

1. Dimension J applies to each end of the output ceramic window.
2. Dimension K is the minimum diameter hole thru which the lower section of the tube will pass to rest the tube on the mounting surface.
3. The outer conductor of the input drive line and the filament terminal are common at the tube. Operation of the tube with the outer conductor grounded requires use of an input drive line voltage blocker against filament potential.

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