6952

Beam Power Tube

2 MEGAWATTS PEAK POWER OUTPUT IN SHORT-PULSE SERVICE AT 425 Mc

PULSE LENGTH TO 15 MICROSECONDS

LOW FILAMENT POWER FOR AIRBORNE USE

LIQUID COOLED

For Grid-Driven, Plate-Pulsed Amplifier Applications at Frequencies from 174 to 600 Mc

Electrical:

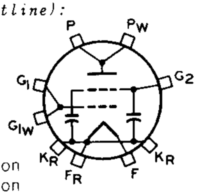
Filamentary Cathode, Multistrand, Matrix-Type, Oxide-Coated:

Voltage:[a]		
Maximum, with dc or 60 cps ac excitation	1.00	volt
Maximum, with 400 cps ac excitation	1.05	volts
Typical, with dc or 60 cps ac excitation	0.95	volt
Current:		
Typical operation value at 0.95 volt, with 60 cps excitation	495	amp
Minimum time to reach operating filament voltage	30	seconds
Minimum time at normal operating filament voltage before other voltages are applied	90	seconds
Mu-Factor, Grid No.2 to Grid No.1	7	
Direct Interelectrode Capacitances:		
Grid No.1 to plate	0.15 max.	pf
Grid No.1 to grid No.2 and cathode	500	pf
Plate to cathode and grid No.2	30	pf
Grid No.2 to cathode (Including bypass capacitors)	18000 max.	pf

Mechanical:

Operating Position	Tube axis vertical, either end up
Overall Length	8.62" ± 0.31"
Maximum Diameter	11.25"
Weight (Approx.)	38 lbs

Terminal Connections (See *Dimensional Outline*):



- F – Insulated Filament Terminal and Coolant Connection
- F_R – Uninsulated Filament Terminal for DC Circuit Returns and Coolant Connection
- G_1 – RF Grid-No.1 Terminal Contact Surface
- G_{1W} – DC Grid-No.1 and Coolant Connection
- G_2 – DC Grid-No.2 and Coolant Connection
- K_R – RF Cathode Terminal Contact Surface for Circuit Returns
- P – RF Plate Terminal Contact Surface
- P_W – DC Plate and Coolant Connection

← Indicates a change.

Thermal:

Ceramic-Insulator Temperature.	150 max.	°C
Metal-Surface Temperature.	100 max.	°C
Minimum Storage Temperature, without cooling liquid in coolant ducts.	-65 min.	°C
External Gas Pressure[b]	60 max.	psia

Air Cooling for Insulators and Contact Areas:

It is important that the temperature of any external part of the tube not exceed the value specified. In general, forced-air cooling of the *ceramic insulators and the adjacent contact areas* may 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 insulators and adjacent terminal areas to limit their maximum temperature to the value specified.

Liquid Cooling:

Liquid cooling of the filament block, dc cathode block, grid-No.1 block, grid-No.2 block, and plate is required. When tube operation under low ambient temperatures is required, the recommended coolant is inert liquid FC75 (Made by the Fluorochemical Division, Minnesota Mining and Manufacturing Co., 900 Bush Avenue, St. Paul 6, Minnesota) but ethylene glycol mixed with water in the proportion of 60% ethylene glycol to 40% water by weight can be used. When the environmental temperature permits, the coolant may be water; the use of distilled water or filtered deionized water is essential. The liquid flow must start before application of any voltages and preferably should continue for several seconds after removal of all voltages. Interlocking of the liquid flow through each of the cooled elements with all power supplies is recommended to prevent tube damage in case of failure of adequate liquid flow.

Flow:

Liquid Pressure at any outlet.	100 max.	psi

Water Flow:

	Absolute Min. Flow *gpm*	*Typical Flow* *gpm*	*Max. Pressure Differential for Typical Flow*[c] *psi*
Through Filament block. . . .	0.5	0.8	8
Through dc cathode block. . .	0.5	0.8	8
Through grid-No.1 block . . .	0.5	0.8	6
Through grid-No.2 block . . .	0.5	0.8	8
Through plate:			
For plate dissipations up to 5 kw (Av.)	5	7	5
For plate dissipations of 5kw to 8 kw (Av.)	8	10	10

Resistivity of Water at 25° C . . . . 1 min. megohm-cm

	Absolute Min. Flow gpm	Typical Flow gpm	Max. Pressure Differential for Typical Flow[c] psi	
Water Temperature from any outlet			70 max.	°C
Storage Temperature			See *footnote* d	
FC75 Flow:				
Through filament block	1.0	1.2	20	
Through dc cathode block	1.0	1.2	20	
Through grid-No.1 block	1.0	1.2	14	
Through grid-No.2 block	1.0	1.2	20	
Through plate:				
For plate dissipation up to 5 kw (Average)	10	12	20	
For plate dissipations of 5 kw to 8 kw (Average)	20	24	80	
Outlet-Liquid FC75 Temperature from any outlet			70 max.	°C
Storage Temperature with liquid FC75 in Coolant Courses			-65 min.	°C
Liquid FC75 Temperature for Tube Operation			-25 min.	°C
Ethylene-Glycol-Water Solution Flow:				
Through filament block	1.0	1.2	18	
Through dc cathode block	1.0	1.2	18	
Through grid-No.1 block	1.0	1.2	12	
Through grid-No.2 block	1.0	1.2	18	
Through plate in direction shown on *Dimensional Outline*:				
For plate dissipation up to 5 kw (Average)	6	8	7	
For plate dissipations of 5 kw to 8 kw (Average)	16	18	40	
Outlet-Solution Temperature from any outlet			60 max.	°C
Min. Plate-Solution-Column Resistance at 25° C.			10 min.	megohms
Storage Temperature with Solution in Coolant Courses			-45 min.	°C
Solution Temperature for Tube Operation			-20 min.	°C

PULSED RF AMPLIFIER

For frequencies from 174 to 600 Mc, and a maximum "ON" time as specified in any 3000-microsecond interval.

Maximum Ratings, *Absolute-Maximum Values:*

	"ON" Time 15 µsec	70 µsec	
Peak Positive-Pulse Plate Voltage[e]	55000 max.	30000 max.	volts

"ON" Time	15 µsec	70 µsec	
Peak Positive-Pulse Grid-No.2 Voltage[f,g]	2200 max.	2200 max.	volts
DC or Peak Negative-Pulse Grid-No.1 Voltage	400 max.	400 max.	volts
Peak Plate Current	80 max.	30 max.	amp
Peak Grid-No.2 Current	15 max.	3 max.	amp
Peak-Rectified Grid-No.1 Current	15 max.	3 max.	amp
DC Plate Current	0.320 max.	0.500 max.	amp
DC Grid-No.2 Current	0.060 max.	0.060 max.	amp
DC Grid-No.1 Current	0.060 max.	0.060 max.	amp
Plate Input (Average)	16000 max.	9000 max.	watts
Plate Dissipation (Average)	8000 max.	5000 max.	watts

Typical Plate-Pulsed Operation:

In Class B service at 425 Mc with a rectangular waveshape pulse.

Pulse width / Duty factor	13 µsec / 0.004	60 µsec / 0.018	
Peak Positive-Pulse Plate Voltage[e]	50000	19000	volts
Peak Positive-Pulse Grid-No.2 Voltage[f]	1800	1700	volts
Peak Negative-Pulse Grid-No.1 Voltage[h]	325	250	volts
Peak Plate Current	75	25	amp
Peak Grid-No.2 Current	8	1	amp
Peak Rectified Grid-No.1 Current	10	0.5	amp
DC Plate Current	0.3	0.45	amp
DC Grid-No.2 Current	0.03	0.02	amp
DC Grid-No.1 Current	0.04	0.01	amp
Peak Driver Power Output (Approx.)	20000	2000	watts
Useful Peak Power Output	2000000	225000	watts

[a] Because the filament, when operated near the maximum voltage value, provides emission in excess of any requirements within tube ratings, during operation of the tube, the filament voltage should be reduced to a value that will give adequate but not excessive emission. Careful attention to maintaining the value of filament voltage consistent with adequate emission will conserve tube life. The filament voltage should be measured at the filament liquid coolant connections on the tube side of the threads. This procedure is essential for accurate measurement of the filament voltage. At 400 cycles some heating of the filament leads and rf cathode terminal (cathode header) occurs; this condition is not detrimental to tube operation or tube life.

[b] This pressure is related to the output-cavity pressurization as required to prevent corona or external arc-over.

[c] Measured directly across cooled element for the indicated typical flow.

[d] The tube coolant ducts must be free of water before storage or shipment of the tube to prevent damage from freezing.

[e] 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 output cavity must be pressurized as required to prevent corona or external arc-over at the ceramic insulator.

[f] The magnitude of any spike on the grid-No.2 voltage pulse should not exceed its peak value by more than 250 volts, and the duration of any spike when measured at the peak-value level should not exceed 10% of the maximum "ON" time.

[g] A negative dc voltage of 300 volts maximum may be applied to grid No.2 to prevent any tube conduction between pulses.

[h] The grid-No.1 voltage may be a combination of fixed and self bias obtained from a series grid resistor.

CHARACTERISTICS RANGE VALUES

	Note	*Min.*	*Max.*	
Filament Current.	j	460	530	amp
Input Strap-Resonant Frequency. . . .	k	222	250	Mc
Output Strap-Resonant Frequency . . .	k	230	250	Mc
Direct Interelectrode Capacitances:				
Grid No.1 to plate.	m	–	0.15	pf
Grid No.2 to cathode.	-	10000	18000	pf

[j] At filament voltage of 0.95 volt and ac filament excitation at 60 cps.

[k] The frequency range of the sweep generator is varied to produce the resonance curve observed on the oscilloscope and the UHF Marker Oscillator frequency is varied so that the pip is observed at the peak of the resonance curve. The resonant frequency is read on the frequency meter.

[m] Measured with special shield adapter.

COOLING CONSIDERATIONS

System

The liquid-cooling system consists, in general, of a source of cooling liquid, a liquid regeneration loop, a heat exchanger, a feed-pipe system which carries the liquid to the filament section blocks, to the filament common-point connection, to the grid-No.1 block, to the grid-No.2 block, and to the plate connections of the tube, and provision for interlocking the liquid flow through each of the cooling courses with the power supplies.

It is essential that the insulating tubing between the cooling-system piping and each of the cooling courses have good insulating qualities and be of sufficient length to minimize leakage currents and/or electrolysis effects. The minimum plate liquid column resistance should be 10 megohms at 25° C.

The piping system must be arranged so that direction of coolant flow through the plate coolant connection is in accord with the markings on the plate coolant connection (see *Dimensional Outline*) to insure adequate cooling. Through each of the other coolant connections, the liquid flow may be in either direction. Series or parallel arrangement of the coolant ducts is permissible so long as the specified flow, pressure, and outlet temperature ratings are observed. *Caution: The feed-pipe system should be so designed that all of the cooling liquid indicated by the flow meter at each outlet passes through the associated coolant duct within the tube, and is not shunted inadvertently by any other path.*

A test as to proper design and functioning of the feed-pipe system can be made by plugging the inlet and outlet holes of the fitting at each cooling connection.

Under these conditions, and with all voltages removed from the tube, no liquid flow should be indicated by the flowmeter for any connection when the coolant valve is fully opened.

Precautions

Proper functioning of the coolant system is of the utmost importance. Even a momentary failure of the liquid flow will damage the tube. In fact, without coolant, 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 coolant supply should fail. This may be done by the use of coolant-flow interlocks which open the power supplies when the flow through any element is insufficient or ceases. The coolant flow must start before application of any voltages and preferably should continue for several seconds after removal of all voltages.

The absolute minimum coolant flow required through the filament section blocks, the filament common-point connections, the grid-No.1 block the grid-No.2 block, and to the plate together with pressure differentials across the cooled elements, is given in the tabulated data. The use of an outlet coolant thermometer and a coolant flow meter at each of the outlets is recommended. Under no circumstances should the temperature of the coolant from any outlet ever exceed the maximum value given for the coolant in the tabulated data.

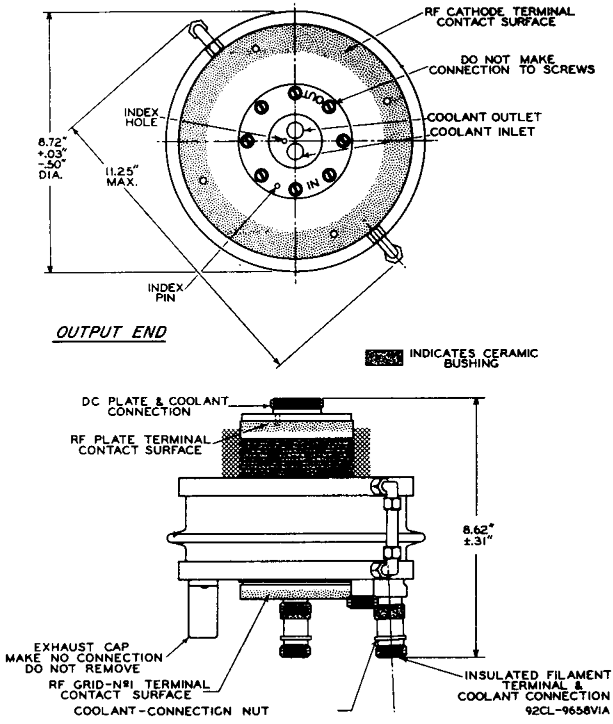
In spite of the usual precautions taken to eliminate contamination of the coolant by oil, dust, etc., some impurities are likely to enter the fluid. The use of a strainer with at least 60-mesh screen is recommended in the coolant supply line as near to the tube as possible to trap any foreign particles likely to impair the coolant flow through the tube ducts. Also, a regeneration loop followed by a submicron filter should be employed. For example, a regeneration loop having a 10-to-20-gallon-per-hour capacity will ordinarily be adequate for use with a cooling system containing about 20 gallons.

When the tube is used in equipment under conditions such that the ambient temperature is below 0° C, precautions should be taken to prevent freezing of the water in the tube ducts.

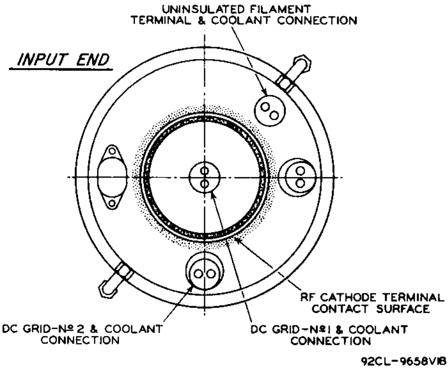
FOR ADDITIONAL INFORMATION ON THIS TYPE INCLUDING INPUT AND OUTPUT CAVITY DRAWINGS, WRITE FOR TECHNICAL BULLETIN AVAILABLE FROM:

Commercial Engineering
Electronic Components and Devices
Radio Corporation of America
Harrison, New Jersey

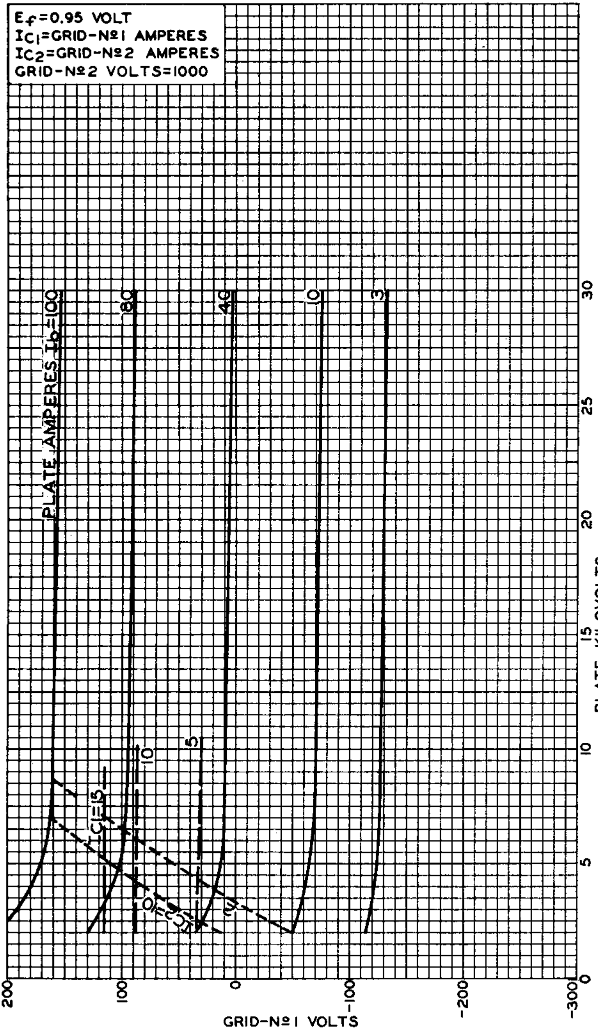
SIMPLIFIED DIMENSIONAL OUTLINE[r]



[r] A detailed Dimensional Outline and associated Gauge Drawings are given in the Technical Bulletin available upon request.


UNINSULATED FILAMENT TERMINAL & COOLANT CONNECTION
INPUT END
RF CATHODE TERMINAL CONTACT SURFACE
DC GRID-№ 2 & COOLANT CONNECTION
DC GRID-№ 1 & COOLANT CONNECTION
92CL-9658V1B

TYPICAL CONSTANT-CURRENT CHARACTERISTICS



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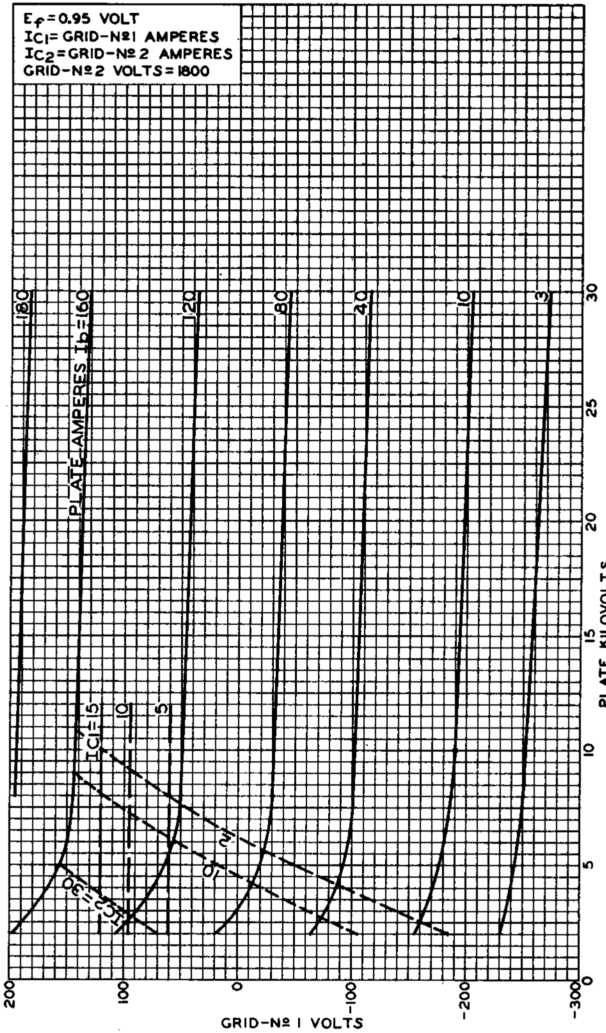
TYPICAL CONSTANT-CURRENT CHARACTERISTICS



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