6161

UHF POWER TRIODE

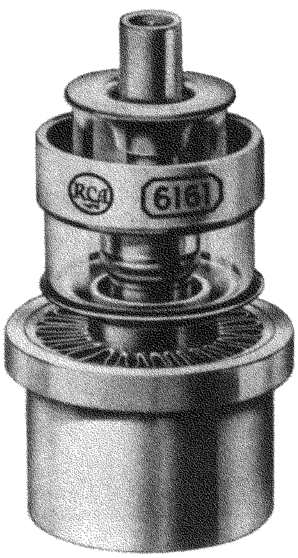
Small Size Coaxial Electrode Structure

Forced-Air-Cooled, Grounded-Grid Type
400 Watts CW Input to 900 Mc
250 Watts CW Input at 2000 Mc

TENTATIVE DATA

3-13/32" Max. Length
1.760" Max. Diameter
Integral Radiator

RCA-6161 is a very compact, forced-air-cooled power triode of the grounded-grid type designed for uhf service in television and cw applications. It has a maximum plate dissipation of 250 watts in cw and television service. The 6161 can be operated with full plate voltage and plate input at frequencies as high as 900 Mc, and with reduced ratings up to 2000 Mc.



Featured in the 6161 is a coaxial-electrode structure designed especially for use with circuits of the coaxial-cylinder type. The design provides low-inductance, large-area, rf electrode terminals for insertion into the cylinders, and permits effective isolation of the plate from the cathode. The latter feature makes the 6161 particularly suitable for grounded-grid circuits.

The 6161 supersedes the type 5588 for new equipment design.

GENERAL DATA

Electrical:

Heater, for Unipotential Cathode:		
Voltage (AC or DC)*	6.3 av. / 6.9 max.	volts / volts
Current	3.4	amperes
Minimum Heating Time	1	minute
Amplification Factor	27	
Direct Interelectrode Capacitances:		
Grid to Plate	6	μμf
Grid to Cathode	11	μμf
Plate to Cathode♦	0.32 max.	μμf

Mechanical:

Mounting Position	Any
Overall Length	3-5/16" ± 3/32"
Greatest Diameter	1.750" ± 0.010"
Radiator	Integral part of tube
Mounting	Special

Air Flow:
The specified air flow for various plate dissipations, as indicated in the tabulation below, should be delivered by a blower onto the respective terminals and seals, and through the radiator before and during the application of any voltages. Heater power, plate power, and air may be removed simultaneously.

Percentage of Max. Rated Plate Dissipation for Each Class of Service	100	80	60	per cent
Minimum Air Flow	16	10	5.7	cfm
Static Pressure	0.85	0.4	0.16	in. of water

The above flow and pressure values are for condition with radiator temperature held constant at 135°C rise above incoming-air temperature. The air flow must be adequate to limit the temperature of the radiator, grid terminal, cathode terminal, and seals to their respective maximum values.

Incoming-Air Temperature	45 max.	°C
Radiator Temperature (Measured on core at end adjacent to plate ring)	180 max.	°C
Grid-Terminal Temperature	150 max.	°C
Cathode-Terminal Temperature	150 max.	°C
Seal Temperature (Plate, grid, and cathode)	150 max.	°C
Weight (Approx.)	8	ounces

RF POWER AMPLIFIER--Class B Television Service

Synchronizing-level conditions unless otherwise specified

Maximum CCS● Ratings, *Absolute Values*:

DC PLATE VOLTAGE	1600 max.	volts
DC PLATE CURRENT	0.350 max.	amp
DC GRID CURRENT	0.100 max.	amp
PLATE INPUT	560 max.	watts
PLATE DISSIPATION	250 max.	watts

Typical Operation in Grounded-Grid Circuit at 600 Mc:
Bandwidth♠ of 6 Mc

DC Plate Voltage	1500	volts
DC Grid Voltage	−100	volts
Peak RF Grid Voltage:		
Synchronizing Level	130	volts
Pedestal Level	117	volts
DC Plate Current:		
Synchronizing Level	0.350	amp
Pedestal Level	0.285	amp
DC Grid Current (Approx.):		
Synchronizing Level	0.040	amp
Pedestal Level	0.013	amp
Driver Power Output (Approx.):♣		
Synchronizing Level	65#	watts
Pedestal Level	40	watts
Output-Circuit Efficiency (Approx.)	89	per cent
Useful Power Output (Approx.):		
Synchronizing Level	325●●	watts
Pedestal Level	195●●	watts

Typical Operation in Grounded-Grid Circuit at 900 Mc:
Bandwidth♠ of 6 Mc

DC Plate Voltage	1500	volts
DC Grid Voltage	−100	volts
Peak RF Grid Voltage:		
Synchronizing Level	135	volts
Pedestal Level	120	volts
DC Plate Current:		
Synchronizing Level	0.350	amp
Pedestal Level	0.280	amp

DC Grid Current (Approx.):		
Synchronizing Level	0.030	amp
Pedestal Level	0.010	amp
Driver Power Output (Approx.):♣		
Synchronizing Level	75⊕	watts
Pedestal Level	45	watts
Output-Circuit Efficiency (Approx.)	65	per cent
Useful Power Output (Approx.):		
Synchronizing Level	230●●	watts
Pedestal Level	135●●	watts

GRID-MODULATED RF POWER AMPLIFIER--Class C Television Service

Synchronizing-level conditions unless otherwise specified

Maximum CCS● Ratings, *Absolute Values:*

DC PLATE VOLTAGE	1600 max.	volts
DC GRID VOLTAGE (White level)	-300 max.	volts
DC PLATE CURRENT	0.350 max.	amp
DC GRID CURRENT	0.100 max.	amp
PLATE INPUT	560 max.	watts
PLATE DISSIPATION	250 max.	watts

Typical Operation in Grounded-Grid Circuit at 600 Mc:

Bandwidth♠ of 6 Mc

DC Plate Voltage	1500	volts
DC Grid Voltage:		
Synchronizing Level	-100	volts
Pedestal Level	-150	volts
White Level	-230	volts
Peak RF Grid Voltage	130	volts
DC Plate Current:		
Synchronizing Level	0.350	amp
Pedestal Level	0.250	amp
DC Grid Current (Approx.):		
Synchronizing Level	0.040	amp
Pedestal Level	0.013	amp
Driver Power Output (Approx.):♣		
Synchronizing Level	65#	watts
Output-Circuit Efficiency (Approx.)	89	per cent
Useful Power Output (Approx.):		
Synchronizing Level	325●●	watts
Pedestal Level	195●●	watts

Typical Operation in Grounded-Grid Circuit at 900 Mc:

Bandwidth♠ of 6 Mc

DC Plate Voltage	1500	volts
DC Grid Voltage:		
Synchronizing Level	-100	volts
Pedestal Level	-150	volts
White Level	-230	volts
Peak RF Grid Voltage	135	volts
DC Plate Current:		
Synchronizing Level	0.350	amp
Pedestal Level	0.250	amp
DC Grid Current (Approx.):		
Synchronizing Level	0.030	amp
Pedestal Level	0.010	amp
Driver Power Output (Approx.):♣		
Synchronizing Level	75⊕	watts
Output-Circuit Efficiency (Approx.)	65	per cent
Useful Power Output (Approx.):		
Synchronizing Level	230●●	watts
Pedestal Level	135●●	watts

PLATE-MODULATED RF POWER AMPLIFIER--Class C Telephony

Carrier conditions per tube for use with a max. modulation factor of 1.0

Maximum CCS● Ratings, *Absolute Values:*

DC PLATE VOLTAGE	1300 max.	volts
DC GRID VOLTAGE	-300 max.	volts
DC PLATE CURRENT	0.210 max.	amp
DC GRID CURRENT	0.075 max.	amp
PLATE INPUT	270 max.	watts
PLATE DISSIPATION	167 max.	watts

Typical Operation in Grounded-Grid Circuit at 600 Mc:

DC Plate Voltage	1250	volts
DC Grid Voltage	-150	volts
From grid resistor of	2150	ohms
Peak RF Grid Voltage	200	volts
DC Plate Current	0.210	amp
DC Grid Current (Approx.)	0.070	amp
Driver Power Output (Approx.)♣	70**	watts
Output-Circuit Efficiency (Approx.)	80	per cent
Useful Power Output (Approx.)	180●●	watts

Typical Operation in Grounded-Grid Circuit at 900 Mc:

DC Plate Voltage	1250	volts
DC Grid Voltage	-150	volts
From grid resistor of	2150	ohms
Peak RF Grid Voltage	200	volts
DC Plate Current	0.210	amp
DC Grid Current (Approx.)	0.070	amp
Driver Power Output (Approx.)♣	75⊕	watts
Output-Circuit Efficiency (Approx.)	60	per cent
Useful Power Output (Approx.)	120●●	watts

RF POWER AMPLIFIER & OSC.--Class C Telegraphy□ and RF POWER AMPLIFIER--Class C FM Telephony

Maximum CCS● Ratings, *Absolute Values:*

DC PLATE VOLTAGE	1600 max.	volts
DC GRID VOLTAGE	-300 max.	volts
DC PLATE CURRENT	0.250 max.	amp
DC GRID CURRENT	0.075 max.	amp
PLATE INPUT	400 max.	watts
PLATE DISSIPATION	250 max.	watts

Typical Operation as Amplifier in Grounded-Grid Circuit at 600 Mc:

DC Plate Voltage	1500	volts
DC Grid Voltage:		
From fixed supply of	-150	volts
From grid resistor of	3000	ohms
From cathode resistor of	500	ohms
Peak RF Grid Voltage	200	volts
DC Plate Current	0.250	amp
DC Grid Current (Approx.)	0.050	amp
Driver Power Output (Approx.)♣	75▲	watts
Output-Circuit Efficiency (Approx.)	82	per cent
Useful Power Output (Approx.)	270●●	watts

Typical Operation as Amplifier in Grounded-Grid Circuit at 900 Mc:

DC Plate Voltage	1500	volts
DC Grid Voltage:		
From fixed supply of	-150	volts
From grid resistor of	15000	ohms
From cathode resistor of	575	ohms
Peak RF Grid Voltage	200	volts
DC Plate Current	0.250	amp
DC Grid Current (Approx.)	0.010	amp
Driver Power Output (Approx.)♣	80†	watts
Output-Circuit Efficiency (Approx.)	60	per cent
Useful Power Output (Approx.)	180●●	watts

FREQUENCY MULTIPLIER--Class C

Maximum CCS● Ratings, *Absolute Values:*

DC PLATE VOLTAGE	1600 max.	volts
DC GRID VOLTAGE	-300 max.	volts
DC PLATE CURRENT	0.250 max.	amp
DC GRID CURRENT	0.075 max.	amp
PLATE INPUT	400 max.	watts
PLATE DISSIPATION	250 max.	watts

Typical Operation in Grounded-Grid Circuit:

	Doubler to 600 Mc	*Doubler to 900 Mc*	
DC Plate Voltage	1500	1500	volts
DC Grid Voltage:			
From fixed supply of	-260	-175	volts
From grid resistor of	5200	8300	ohms
From cathode resistor of	860	645	ohms
Peak RF Grid Voltage	300	300	volts
DC Plate Current	0.250	0.250	amp
DC Grid Current (Approx.)	0.050	0.021	amp
Driver Power Output (Approx.)♣	125	100	watts
Output-Circuit Efficiency (Approx.)	90	80	per cent
Useful Power Output (Approx.)	180●●	140●●	watts

MAXIMUM RATINGS vs OPERATING FREQUENCY

FREQUENCY	900	1200	1400	1650	2000	Mc
MAX. PERMISSIBLE PERCENTAGE OF MAX. RATED PLATE VOLTAGE AND PLATE INPUT:						
Class B Television	100	80	71	62.5	62.5	%
Class C Television, Grid-Modulated	100	80	71	62.5	62.5	%
Class C Telephony, Plate-Modulated	100	80	71	62.5	62.5	%
Class C Telegraphy	100	80	71	62.5	62.5	%
Class C FM Telephony	100	80	71	62.5	62.5	%

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

	Note	*Min.*	*Max.*	
Heater Current	1	3.05	3.75	amp
Amplification Factor . . .	1,2	20	34	
Grid-Plate Capacitance . .	-	5.5	6.5	μμf
Grid-Cathode Capacitance .	-	9.6	12.4	μμf
Plate-Cathode Capacitance.	3	-	0.32	μμf
Plate Voltage.	1,4	550	810	volts
Plate Voltage.	1,5	750	1150	volts
Grid Voltage	1,6	-	-165	volts
Peak Cathode Current . . .	1,7	9	-	amp
Useful Power Output. . . .	1,8	225	-	watts

Note 1: With 6.3 volts ac on heater.
Note 2: With dc grid voltage of -15 volts, and dc plate voltage adjusted to give dc plate current of 250 ma.
Note 3: With external shield, as described under (♦) connected to grid terminal.
Note 4: With dc grid voltage of -10 volts, and dc plate voltage adjusted to give dc plate current of 250 ma.
Note 5: With dc grid voltage of -20 volts, and dc plate voltage adjusted to give dc plate current of 250 ma.
Note 6: With dc plate voltage of 1600 volts, and dc grid voltage adjusted to give dc plate current of 1.0 ma.
Note 7: Designers should limit the maximum useable cathode current (plate current and grid current) to this value under any condition of operation.
Note 8: In a self-excited oscillator circuit and with dc plate voltage of 1600 volts, dc plate current of 250 ma., dc grid current of 50 to 75 ma., grid resistor of 2000 ± 10% ohms, and frequency of 15 Mc.

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* Because the cathode is subjected to considerable back bombardment as the frequency is increased with resultant increase in temperature, the heater voltage should be reduced depending on operating conditions and frequency to prevent overheating the cathode and resultant short life.

♦ With external flat shield 7-1/2" min. diameter located in plane of the grid terminal and perpendicular to axis of tube. Shield is connected to grid terminal.

● Continuous Commercial Service.

♠ Computed between half-power points and based on tube output capacitance only.

♣ The driver stage is required to supply tube losses, rf circuit losses, and rf power added to plate input. The driver stage should be designed to provide an excess of power above the indicated value to take care of variations in line voltage, in components, in initial tube characteristics, and in tube characteristics during life.

This value includes 24 watts of circuit loss and 36 watts added to plate input.

●● This value of useful power is measured at load of output circuit having indicated efficiency.

⊕ This value includes 28 watts of circuit loss and 40 watts added to plate input.

** This value includes 18 watts of circuit loss and 40 watts added to plate input. In grounded-grid, plate-modulated class C rf power amplifier service, the 6161 can be modulated 100% if the rf driver stage is also modulated 100% simultaneously. Care should be taken to insure that the driver-modulation and amplifier-modulation voltages are exactly in phase.

❉ This value includes 23 watts of circuit loss and 40 watts added to plate input.

□ Key-down conditions per tube without amplitude modulation. Modulation essentially negative may be used if the positive peak of the audio-frequency envelope does not exceed 115% of the carrier conditions.

▲ This value includes 18 watts of circuit loss and 45 watts added to plate input.

† This value includes 23 watts of circuit loss and 45 watts added to plate input.

OPERATING CONSIDERATIONS

The *maximum ratings* shown in the tabulated data are limiting values above which the serviceability of the 6161 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 for each rating below the absolute value of that rating by an amount such that the absolute values will never be exceeded under any usual conditions of supply-voltage variation, load variation, or manufacturing variation in the equipment itself.

The maximum radiator temperature of 180°C as well as the maximum terminal and seal temperatures of 150°C are tube ratings and are to be observed in the same manner as other ratings. The temperature of the radiator should be measured on the core at the end adjacent to the plate ring (see *Outline Drawing*). The temperature may be measured either with a thermocouple or with temperature-sensitive paint, such as Tempilaq The latter is made by the Tempil Corporation, 132 W. 22nd Street, New York 11, N.Y., in the form of liquid and stick, and is stated by the maker to have an accuracy of 1 per cent.

In *transportation and storage* of the 6161, care should be taken to protect the tube from rough handling that would damage the glass-to-metal seals or dent or mar the rf contact surfaces. Particular care should be taken not to subject the tube to severe shock which might permanently deform the internal elements. It is recommended that the tube be tested upon receipt in the equipment in which it is to be used.

The *mounting* may be arranged to support the 6161 in any position. The tube may be supported by the plate ring or by the radiator in any convenient way, but the mounting arrangement used must not subject the grid, cathode, and heater terminals to undue stress.

Because the terminals of the 6161 have progressively smaller diameters from plate to grid to cathode to heater as shown in the *Outline Drawing*, it is possible to insert the 6161 into coaxial and cavity circuits from one end without disassembly of the circuit. In such circuits, the 6161 is supported by the plate ring as shown in Fig. 1.

In the design of this mounting, it is to be noted that the hole in part A, which limits movement of the tube in directions parallel to the plate contact surface, is approximately 0.050" larger than the maximum diameter of the plate ring in order to allow the tube to seek its position freely when being inserted into the grid, cathode, and heater contacts, and to seat properly on the plate contact surface of part B. After the tube is in place, the removable clamp C is brought into position and closed to make the plate contact secure and to anchor the tube firmly in place.

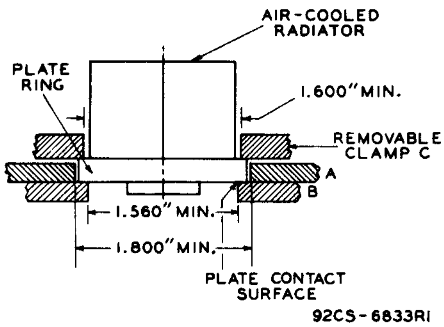


Fig. 1 - Mounting Arrangement for Use with Coaxial-Line or Cavity Circuits.

In addition to the dimensions shown in Fig. 1, the equipment designer should also observe the diameter tolerances on the grid, cathode, and heater terminals and the limits on concentricity defined by the gauge (see *Outline Drawing*) in order to provide for variation from tube to tube.

Cooling of the 6161 is accomplished by delivering a stream of clean air from a blower onto the respective terminals and seals, and through the radiator before and during the application of any voltages. The air flow through the radiator may be in either direction. The minimum rate of air flow for various plate dissipations is shown in the tabulated data. A suitable air filter is required in the air supply. Care should be given to cleaning or replacing the filter at intervals in order that accumulated dirt will not obstruct the required flow of air through the radiator. When the 6161 is operated at full ratings, a flow of at least 16 cubic feet per minute at a pressure of about 0.85 inch of water is recommended.

The cooling system should be properly installed to insure safe operation of the 6161 under all conditions and for this reason should be electrically interconnected with the heater and plate power supplies. This arrangement is necessary to make sure that the tube is supplied with air before any voltages are applied. Air pressure interlocks which open the power transformer primary of the heater supply and the plate supply are desirable for protecting the tube when the air flow is insufficient or ceases.

The *heater* of the 6161 should be operated at constant voltage rather than constant current. The rated heater voltage of 6.3 volts should be applied for at least 1 minute to allow the cathode to reach normal operating temperature before voltages are applied to the other electrodes.

The *unipotential cathode* is indirectly heated by the heater, one terminal of which is common to the cathode. The cathode of the 6161 in uhf service is subjected to considerable bombardment resulting from transit-time effects. This back bombardment raises the temperature of the cathode. The magnitude of the heating caused by back bombardment is a function of the operating conditions and frequency, and must be compensated by reduction of the heater input in order to prevent overheating of the cathode and resultant short life. When long life in continuous service

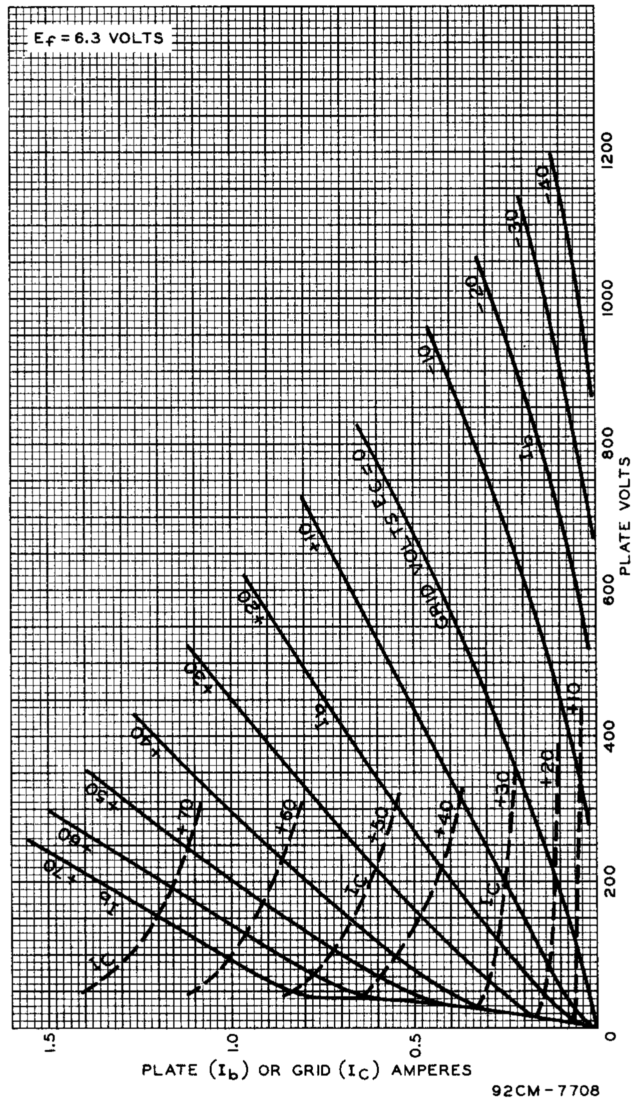


Fig. 2 - Average Characteristics of Type 6161.

is desired, the 6161 should always be put in operation with full rated heater voltage (6.3 volts) which should then be reduced to the lowest value that will give the desired power output. Because the cathode of this tube when operated with a heater voltage of 6.3 volts provides emission usually in excess of any requirements within ratings, it is recommended that the heater voltage be reduced below 6.3 volts to a value that will give adequate but not excessive emission from the cathode for any particular application. The proper operating value may then be found by reducing the heater voltage, with normal modulation applied to the transmitter, until a reduction in output is observed. The heater voltage must then be increased by an amount equivalent to the maximum percentage regulation of the heater-voltage supply, and then further increased by about 0.1 volt to allow for other variations. After the heater voltage is reduced, circuit re-adjustment may be necessary. It is suggested that the adjustment procedure be carried out daily. However, if no significant changes in the operating voltage are found necessary, the adjustment procedure can be scheduled less frequently. Good regulation of the heater voltage is in general economically advantageous from the viewpoint of tube life.

The *grid* of the 6161 in uhf service is subjected to heating caused not only by the normal electron bombardment as indicated by the grid current, but also by bombardment due to transit-time effects and by circulating rf currents. For these reasons, more than ordinary care must be taken during operation to prevent overloading the grid.

The *plate* should be protected against overload. The protective device, such as a fuse in the plate circuit, should remove the dc plate voltage when the average value of plate current reaches a value 50% above normal.

Average characteristics for the 6161 are shown by the curves in Fig.2.

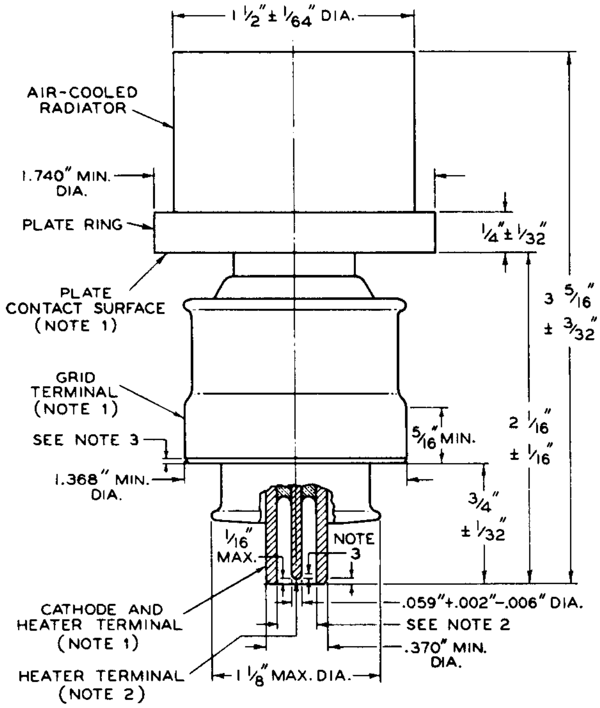
In *tuning a grounded-grid rf amplifier*, it must be remembered that variations in the load on the output stage will produce corresponding variations in the load on the driving stage. This effect will be noticed by the simultaneous increase in plate currents of both the output and driving stages.

During *standby periods* of less than 15 minutes, it is recommended that the heater voltage be reduced to 80% of normal to conserve life; for longer standby periods, the heater power should be turned off.

REFERENCE

E. E. Spitzer, *"Grounded-Grid Power Amplifiers,"* Electronics, Vol.19, No.4, pp. 138-141 (April, 1946).

DIMENSIONAL OUTLINE



NOTE 1: WITH THE CYLINDRICAL SURFACES OF ITS GRID AND CATHODE TERMINALS CLEAN, SMOOTH, AND FREE OF BURRS, THE TUBE WILL ENTER A GAUGE AS SHOWN IN SKETCH G1. THE FOUR CYLINDRICAL HOLES H_1, H_2, H_3, AND H_4 HAVE AXES COINCIDENT WITHIN 0.0005", LENGTHS DETERMINED FROM THE OUTLINE DRAWING, AND SUCCESSIVELY SMALLER DIAMETERS AS SHOWN IN THE SKETCH.

THE PLATE RING WILL BE ENTIRELY ENGAGED BY HOLE H_1, AND THE CONTACT SURFACE OF THE PLATE RING WILL SEAT ON THE SHOULDER BETWEEN HOLES H_1 AND H_2. THE PLANE SURFACE OF THIS SHOULDER IS 90° ± 2′ TO THE AXES OF THE HOLES. SEATING IS DETERMINED BY FAILURE OF A 0.005" THICKNESS GAUGE, 1/8" WIDE, TO ENTER MORE THAN 1/16" BETWEEN THE SHOULDER SURFACE AND THE PLATE CONTACT SURFACE.

WITH THE TUBE PROPERLY SEATED AS DESCRIBED ABOVE, THE GRID TERMINAL WILL BE ENTIRELY ENGAGED BY HOLE H_3, AND THE CATHODE TERMINAL WILL BE ENGAGED BY HOLE H_4 TO A DEPTH OF AT LEAST 1/4".

NOTE 2: CONCENTRICITY OF THE HEATER TERMINAL WITH RESPECT TO THE CATHODE TERMINAL IS DETERMINED BY A GAUGE AS SHOWN IN SKETCH G2. THE CYLINDRICAL HOLE H_5 AND THE ANNULAR HOLE H_6 HAVE AXES COINCIDENT WITHIN 0.0005". THE CATHODE TERMINAL AND THE HEATER TERMINAL WILL ENTER THIS GAUGE TO A DEPTH OF 3/8".

NOTE 3: MAY BE ROUNDED OR BEVELED NOT TO EXCEED 1/16".

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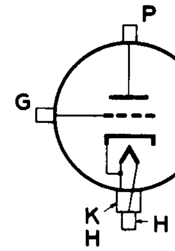
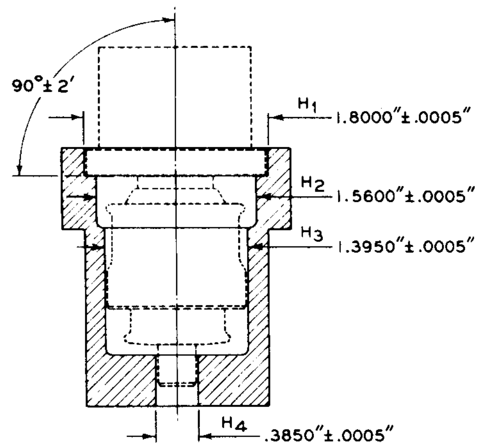
TERMINAL CONNECTIONS

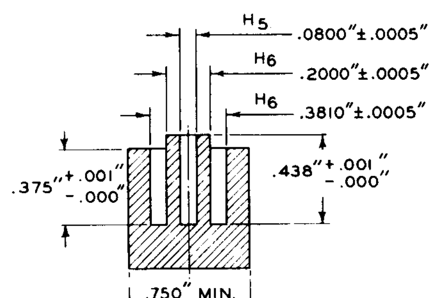


P: PLATE
G: GRID
K: CATHODE
H: HEATER

Sketch G1



Sketch G2



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