5696

THYRATRON

Gas-Tetrode, Miniature Type

TENTATIVE DATA

RCA-5696 is a sensitive, four-electrode thyratron of the indirectly heated cathode type. It features low-heater current drain and short deionization time, and is designed for use in relay applications particularly those involving counter circuits.

The 5696 has a steep control characteristic which is essentially independent of ambient temperature over a wide range. It also has extremely low pre-conduction or gas-leakage currents, low control-grid-to-anode capacitance, and low control-grid current.

Because of the low control-grid-to-anode capacitance, the 5696 is practically insensitive to line voltage surges; and because of its low control-grid current, a high value of resistance can be used in the grid circuit to give high circuit sensitivity. In a high sensitivity circuit, the 5696 can be operated directly from a high-vacuum phototube.

GENERAL DATA

Electrical:

Heater, for Unipotential Cathode:		
Voltage (AC or DC)	6.3	volts
Current	0.150	ampere

Cathode:

Minimum Heating Time prior to tube conduction	10	seconds
Direct Interelectrode Capacitances (With no external shield):		
Grid No.1 to Anode	0.03	μμf
Input	1.8	μμf
Output	0.54	μμf
Ionization Time (Approx.): For conditions: dc anode volts = 100, grid-No.1 square-pulse volts = + 50, peak cathode amperes during conduction = 0.150	0.5	μsec
Deionization Time (Approx.):		
For conditions: dc anode volts = 500, dc grid-No.1 volts = −100, grid-No.1 resistor (ohms) = 1000, dc cathode amperes = 0.025	25	μsec
For conditions: dc anode volts = 500, dc grid-No.1 volts = −13, grid-No.1 resistor (ohms) = 1000, dc cathode amperes = 0.025	40	μsec
Maximum Critical Grid-No.1 Current: For conditions: ac anode-supply volts = 350 (RMS), average cathode amperes = 0.025	0.5	μamp
Anode Voltage Drop (Approx.)	10	volts
Grid-No.1 Control Ratio (Approx.): For conditions: grid-No.1 resistor (ohms) = 0, grid-No.2 volts = 0	250	
Grid-No.2 Control Ratio (Approx.): For conditions: grid-No.1 volts = 0, grid-No.2 resistor (ohms) = 0	15	

Mechanical:

Mounting Position	Any
Maximum Overall Length	1-3/4"
Maximum Seated Length	1-1/2"
Length from Base Seat to Bulb Top (Excluding Tip)	1-1/8" ± 3/32"
Maximum Diameter	3/4"
Bulb	T-5-1/2
Base	Small-Button Miniature 7-Pin

Maximum Ratings, *Absolute Values*:

PEAK ANODE VOLTAGE:		
Forward	500 max.	volts
Inverse	500 max.	volts
GRID-No.2 VOLTAGE:		
Peak, before anode conduction	−50 max.	volts
Average, during anode conduction	−10 max.	volts
GRID-No.1 VOLTAGE:		
Peak, before anode conduction	−100 max.	volts
Average, during anode conduction	−10 max.	volts
CATHODE CURRENT:		
Peak	0.100 max.	ampere
Average▲	0.025 max.	ampere
Surge, for duration of 0.1 second maximum	2 max.	amperes
AVERAGE GRID-No.2 CURRENT▲	0.005 max.	ampere
AVERAGE GRID-No.1 CURRENT▲	0.005 max.	ampere
PEAK HEATER-CATHODE VOLTAGE:		
Heater negative with respect to cathode	100 max.	volts
Heater positive with respect to cathode	25 max.	volts
AMBIENT TEMPERATURE RANGE	−55 to +90	°C

Typical Operation in Relay Service:

AC Anode Voltage (RMS)	117	volts
Grid No.2	Connected to cathode at socket	
Grid-No.1 Bias Voltage (RMS)♯	5	volts
Grid-No.1 Signal Voltage (Peak)	5	volts
Grid-No.1-Circuit Resistance	0.1	megohm
Anode-Circuit Resistance◇	5000	ohms

Maximum Circuit Value:

Grid-No.1-Circuit Resistance	10	megohms

▲ Averaged over a period not exceeding 30 seconds.

♯ Approximately 180° out of phase with the anode voltage.

◇ Sufficient resistance including the tube load must be used under any conditions of operation to prevent exceeding the current ratings.

INSTALLATION

The *base* pins of the 5696 fit the miniature 7-pin socket which may be installed to hold the tube in any position. The socket should be made of any insulating material having low leakage.

The *heater* is designed to operate on either ac or dc at 6.3 volts. When it is operated on ac with a transformer, the heater winding should operate the heater at its recommended voltage value for full-load operating conditions at average line voltage. When it is operated from a battery with charger attached, provision must be made through the use of regulation-control devices to hold the voltage across the heater to

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the recommended value. Regardless of the heater-voltage supply used, ***the heater voltage must never be allowed to deviate more than 10% from its rated value.*** Heater operation outside of this voltage range will impair tube performance and may cause tube failure. Series heater operation is not recommended. Low heater voltage causes low cathode temperature with resultant cathode sputtering and consequent destruction of the cathode; high heater voltage causes high cathode temperature with resultant heating of grid No.1 and consequent grid emission which produces unpredictable shifts in the critical grid voltage for conduction.

The ***cathode*** should be allowed to reach normal operating temperature before tube conduction is permitted to start. The delay period should be not less than 10 seconds after application of the heater voltage. Unless this recommendation is followed, the cathode will be damaged.

When the heater of the 5696 is operated from a transformer, the cathode should preferably be connected directly to the mid-point or to one side of the heater circuit. When the 5696 is used in equipment employing a storage battery for the heater supply, the cathode circuit is usually tied directly to the negative side of the heater supply. In circuits where the cathode is not connected directly to the heater, the potential difference between them should never exceed the recommended peak potentials shown in the tabulated data.

A ***grid-No.1 resistor*** having a value of 0.1 megohm is recommended for the usual application. If, however, the source of the control-grid signal has high internal impedance, it may be desirable to use a higher value of grid-No.1 resistor in order to apply as large a signal as possible to the control grid. A value as high as 10 megohms may be used with the 5696 because its control-grid current is low. However, when a grid-No.1-circuit resistor having a value of 10 megohms is used, the tube base and socket should be kept clean and dry in order to make the effect of leakage currents between the control-grid base pin and the anode base pin small.

When the 5696 is operated with a high value of grid-No.1 resistor and ac voltage on the anode, the circuit capacitance between grid No.1 and anode should be kept low by placing the grid-No.1 resistor directly at the socket grid terminal, by connecting both grid-No.2 terminals (pins 5 and 7) to the cathode (pin 2) at the socket, and by using a close-fitting shield connected to the cathode terminal.

Sufficient anode-circuit resistance, including the tube load, must be used under any conditions of operation to prevent exceeding the current ratings of the tube.

APPLICATION

The 5696 has a ***critical control-grid voltage*** which will initiate tube conduction for any specific grid-No.2 voltage and positive anode voltage. If the control grid is maintained more negative than this critical voltage, the tube does not conduct and the anode current remains zero. If the control grid is made less negative than this critical voltage, the tube will conduct

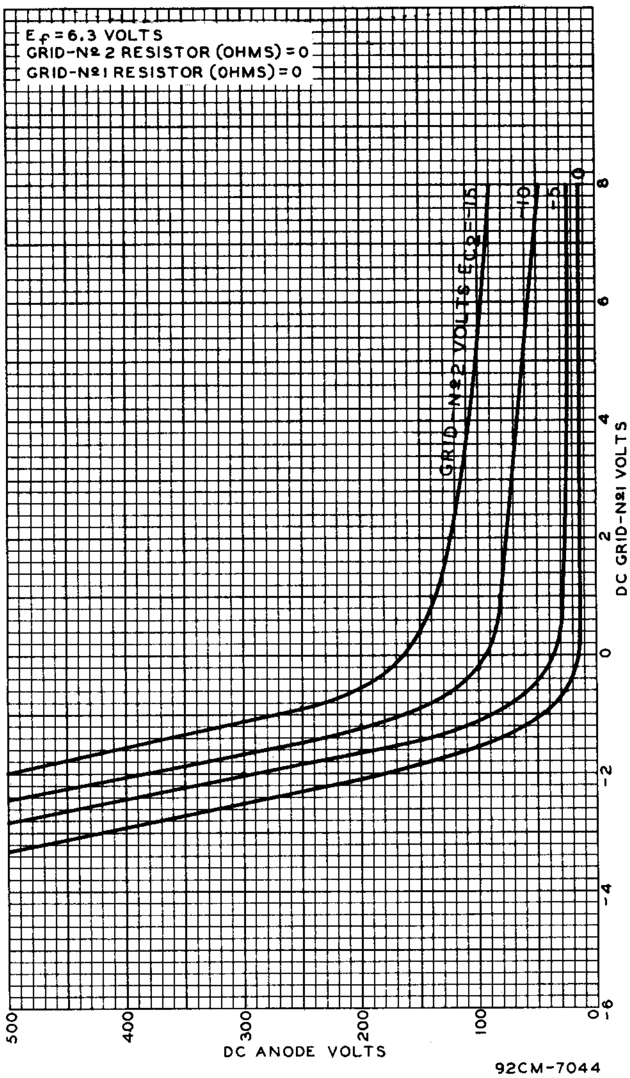


Fig.1 – Average Control Characteristics.

and the anode current assumes a value determined by the applied anode voltage and the impedance in the anode circuit. In the conducting condition, the 5696 has a voltage drop which is relatively low, substantially constant over the rated anode-current range, and independent of grid-No.1 bias. Conduction may be stopped and grid No.1 allowed to regain control by reducing the anode voltage to zero or making it negative. A family of curves showing the relation between grid-No.1 (control) volts, grid-No.2 (shield) volts, and anode voltage is shown in Fig. 1.

The value of critical grid voltage is affected by several factors including: the operating anode voltage, grid-No.2 voltage, variations of heater-supply voltage, value of grid-No.1 resistor, and individual tube variation both initially and during life. Fig. 2 shows the range of critical control-grid voltage. The range takes into account the combined effect of individual tube variation and variation throughout tube life for a grid-No.1 resistor value of 0.1 megohm and also for a value of 10 megohms. About 10% of the total variation range for any particular operating condition is attributable to a heater-voltage variation of ± 10% from the rated value.

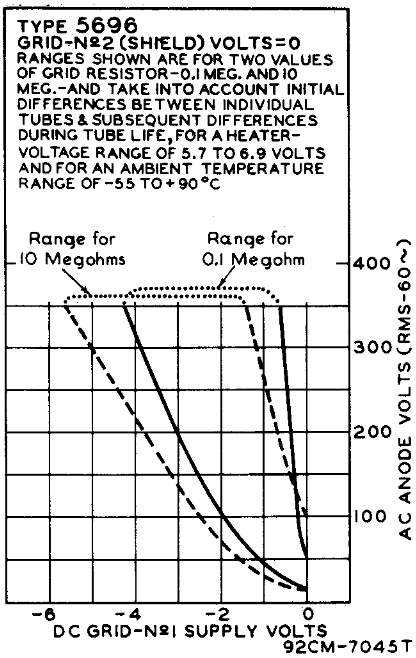


Fig.2 - Operational Range of Critical Grid Voltage.

The equipment designer should give careful consideration to the range values shown in Fig. 2. From them he can determine for specified operating conditions not only the proper value of control-grid bias necessary to prevent conduction until it is desired, but also the magnitude of the signal (triggering) voltage necessary to initiate conduction. Ample triggering voltage should always be provided to insure anode conduction even under the worst operating conditions to which the equipment will usually be subjected.

The effective control-grid bias obtained when a high value of grid-No.1 circuit resistor is used is influenced by the grid currents flowing before and during conduction. These currents consist of leakage currents, gas currents, grid-emission currents, and capacitive currents. Except for capacitive currents, the magnitude of all these currents before conduction is shown in microamperes in Fig. 3, and during conduction in milliamperes in Fig. 4. The capacitive current appears only when the anode is supplied with ac voltage, and,

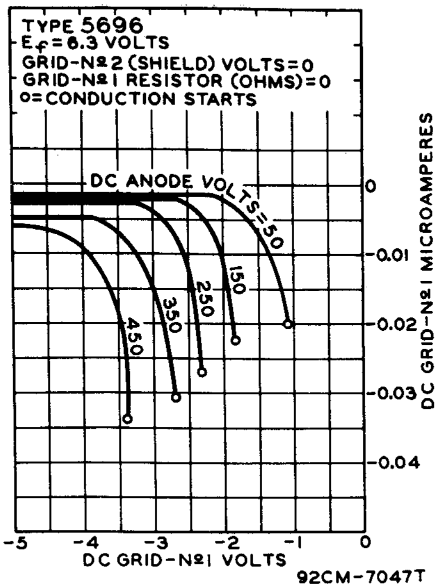


Fig.3 - Average Characteristics Before Anode Conduction.

since the shield-grid construction of the 5696 provides low grid-anode capacitance, these capacitive currents are consequently low. A further advantage in having low grid-anode capacitance is to make the tube relatively insensitive to line-voltage surges.

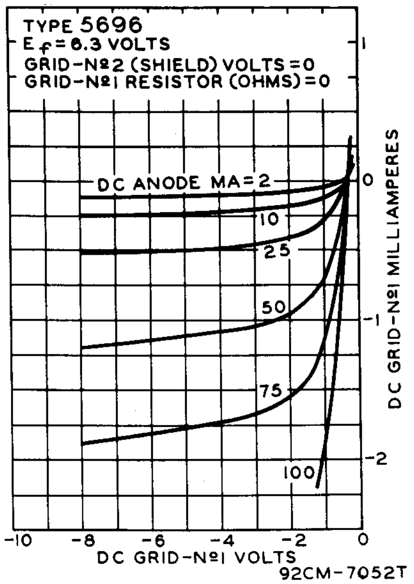


Fig.4 - Average Characteristics During Anode Conduction.

The advantage in having a low value of control-grid current is that the control characteristic will remain relatively fixed as the grid resistor is increased in value.

The ***anode voltage*** for the 5696 may be obtained from either an ac or dc source and should never be less than 100 volts in order to insure stable tube operation. When a dc supply is used, the circuit has a lock-in feature because the grid loses control when conduction starts. In order for the grid to regain control and restore the tube to the non-conducting condition, it is necessary to remove the anode voltage momentarily. When an ac supply is used, the circuit has no lock-in feature because the anode becomes negative during the negative half of the ac cycle and thus allows the grid to resume control before the next positive half-cycle.

With an ac supply, control of the firing of the 5696 may be accomplished by varying the amplitude of the ac control-grid voltage, by varying a dc bias applied to the control grid, by phasing a sinusoidal control-grid voltage with respect to the anode voltage, by phasing a peaked grid voltage with respect to the anode voltage, or by a combination of these methods. A typical light-operated relay circuit is shown in Fig. 5.

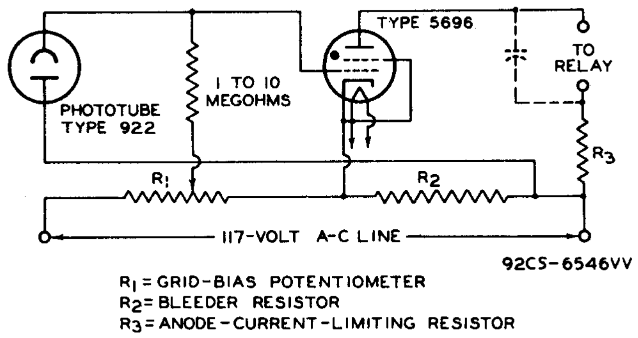
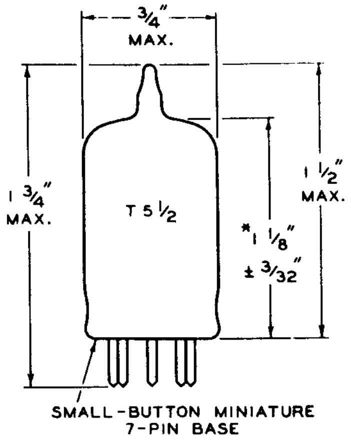


Fig.5 - Typical Light-Operated Relay Circuit.

In addition to the factors contributing to the range values shown in Fig. 2, the effect of high ambient temperature may become important. Ambient temperature changes between -55° to +90°C have negligible effect on critical grid voltage when the 5696 is operated with a low value of grid-No.1 resistor. However, when the grid resistor has a high value, temperature changes within the operating range of -55°C to +90°C may cause a change of 20% in the critical grid voltage. Most of this change occurs at the higher temperatures and is caused by leakage outside the tube. Therefore, under operating conditions involving a high value of grid resistor and high ambient temperature, it is essential that precautions be taken to minimize leakage.

The ***maximum average cathode current*** is the highest current which can be drawn continuously through the tube. The average current should be determined on the basis of 30-second operation of the tube. If the cycle of operation during the 30-second period is rapid, the average current can be read on a dc meter. If the cycle is long, it is necessary to calculate the average current from readings taken during the 30-second period.

DIMENSIONAL OUTLINE



* MEASURED FROM BASE SEAT TO BULB-TOP LINE AS DETERMINED BY RING GAUGE OF 7/16" I.D.

SOCKET CONNECTIONS
Bottom View