ELECTRON TUBES

RCA Application Note

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Circuit Design Precautions to Prevent Internal Arcs from Damaging Kinescopes

Because kinescopes operate at relatively high voltages and low currents, they are most efficiently used with highly specialized power supplies usually having limited current capabilities. For this reason, it is generally feasible to design television cathode-ray tubes with a lower factor of safety against surges and over-voltages than is required in other high-voltage apparatus. When the stored energy available is low and the peak current is adequately limited, an internal arc in a cathode-ray tube clears quickly and does not damage the tube. When the current and energy of the power supply are not limited, the desired protection may be provided either by utilizing a series resistor which limits the maximum possible peak current to a safe value, or by restricting the storage of energy in the bypass or filter circuit to a maximum value of 250 microcoulombs.

If the stored energy in the filter capacitance of the power supply exceeds 250 microcoulombs, it is recommended that the power supply be designed to limit the peak instantaneous short-circuit current to one ampere. The stored energy or change is given by the relation $Q = CE$ where Q is the charge in microcoulombs, C is the capacitance in microfarads, and E is the voltage in volts. In order to limit the peak electrode current to one ampere, it is recommended that the resistance in the circuit between each electrode (grid No.1, grid No.2, anode No.1, and anode No.2) and the output capacitor of the power supply be not less than the minimum value given in Table I. If CE is 250 microcoulombs or less, the limiting resistance may be omitted, although the use of such a resistance provides an additional safety factor.

To prevent damage to the heater and cathode when the tube arcs internally a further precaution is necessary. An arc in a cathode-ray tube is usually initiated between the high-voltage anode and an adjacent electrode which is exposed to a high voltage gradient. This arc may then transfer to other electrodes because of ionized gas. Electrodes with high impedances in their external circuits may not sustain the arc because the voltage drop is transferred to the impedance; but, nevertheless, a voltage high enough to break down internal insulation may be produced. The heater

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insulation is particularly subject to this type of failure. Furthermore, when an arc forms between heater and cathode, the added heat due to the arc may cause the heater to burn out or short to the cathode.

In order to minimize the possibility of burning out the heater or of causing a short circuit, it is recommended that the heater be connected directly to the cathode whenever possible. If it is not possible to connect the heater and cathode because of circuit design considerations, precautions must be taken to make sure that heater-cathode voltage does not exceed the maximum value shown in the tube data even for the condition of arc-over between anode and cathode.

TABLE I. Minimum Values of Resistance Between Indicated Electrode and Output Capacitor.

Electrode	*5TP4*	*7DP4*	*7JP4**	*10BP4†*	
Grid No.1	180	150	220	150	ohms
Grid No.2	390	450	-	470	ohms
Anode No.1	6800	2700	3000	11000	ohms
Anode No.2	30000	9100	6800	-	ohms

* Type 7JP4 has grid No.2 and anode No.2 connected internally.
† Type 10BP4 has only one anode.