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PHOTOCATHODE PROTECTION CIRCUIT

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PHOTOCATHODE PROTECTION CIRCUIT

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A photocathode protection circuit applicable to high voltage electron multiplier devices has been developed and successfully used. Application to a Westinghouse WL-23111 image dissector tube is described. The protection circuit features the positive firing action of a silicon-controlled rectifier, current cutoff by reverse biasing of the photocathode, and photocathode current calibration and monitoring. Inherent safeguard against socket leakage and arcing is also discussed.

Introduction

When working with photosensitive devices it is often desirable to have some means of protection against accidental flooding of the photocathode with excessive light flux. Permanent damage to or destruction of the photo device can result from such accidents. This is especially true when using high-voltage electron multiplier devices such as the image orthicon, the image dissector, or any multiplier phototube.

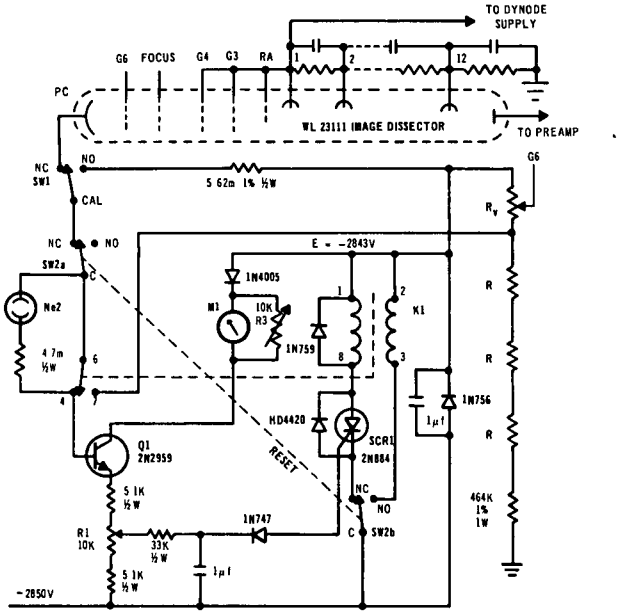
Cognizance of this problem at the Visibility Laboratory led to the development of the Photocathode Protection Circuit shown in Fig. 1 and described below. With the components as shown, the protective action can be set to occur at photocathode currents from a few tenths of a microampere to several microamperes. Rearrangement of the Q1 emitter resistors permits extension of this range.

Description of Operation

The firing point of the silicon-controlled rectifier, SCR 1, is set by means of adjusting the control R1 such that protection activation occurs when the photocathode current is of the desired magnitude. Firing SCR 1 energizes K1 relay which transfers the photocathode from its most negative potential [$\approx$ E] to a more positive voltage .8E. Since .8E is more positive than the G6 voltage, the photocathode is effectively biased off and electron flow is prevented irrespective of the incident light flux. The neon tube Ne-2 is ignited by the protective switching and serves as an indication of the state of the protection circuit.

Because of its permanent magnet armature construction, K1 remains in the protective position until it is reset by SW 2b. After resetting, the circuit remains in the normal operation mode or else immediately trips, depending on the magnitude of the photocathode current. SW 2a and SW 2b are separate, mechanically ganged Micro-switches adjusted so that when initially pressed, SW 2a opens before SW 2b opens; when depressed, SW 2b closes before SW 2a closes. This arms the protective SCR 1 so that it is ready to function before the photocathode circuit is closed through SW 2a.

The 33K resistor and the 1 μf capacitor shown in the SCR 1 gate circuit act as a low pass filter and serve to prevent undesired firing of the SCR when uncapping the photocathode.



K1: Potter + Brumfield
MDP-1300-8
4000Ω/coil

M1: Simpson 1212
0-50μA
5300Ω

R: 511K, 1%, 1W
RN75B or equivalent

R_V: Bourns 3501S-1-504
500K

Fig. 1. Photocathode Protection Circuit

Calibration Feature

Utilizing the voltage divider usually available when operating the phototube, one can cause a known current to flow in the base circuit of Q1 by setting SW 1 to the N.O. position (CAL). R3 is then adjusted to set the meter M1 at a desired deflection. Circuit stability and calibration can then be periodically checked as desired. The meter also serves to indicate the average photocathode current during normal operation. It provides for a current sensitivity of 5 microamperes full scale at a point in the circuit that is 2850 volts negative with respect to ground. Conventional methods of current metering would be difficult to employ in this situation since a passive meter of this sensitivity would probably be adversely affected by the electrostatic field.

Application to Image Dissector

The Photocathode Protection Circuit of Fig. 1 has been in use on a Westinghouse WL-23111 image dissector for several months at the Visibility Laboratory. Operation has been reliable, repeatable, and quite satisfactory. It is worth mentioning with regard to this tube (mechanically equivalent to the 5820-type image orthicon) that protection against excessive or catastrophic leakage through its jumbo annular socket is provided by the protection circuit. We have been able to find only one such socket available commercially. Designed for image orthicon use, where its pin voltages are near ground, it is made of Bakelite. When used with the image dissector, its pin voltages are about -2500V, socket leakage is about .3 microamperes and is, of course, somewhat dependent on humidity, dust, and mechanical pressures. Since arcing and leakage in this socket have been bothersome, and we have been unable to locate a superior commercial socket, a replacement socket of Kel-F has been constructed by our own machine shop. This is expected to eliminate the problem entirely.

The cost of the components for the Photocathode Protection Circuit is about $100 which, relative to the $3,000 cost of the image dissector tube, is not unreasonable.

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