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ELECTRON DISCHARGE TUBE TESTING CIRCUIT

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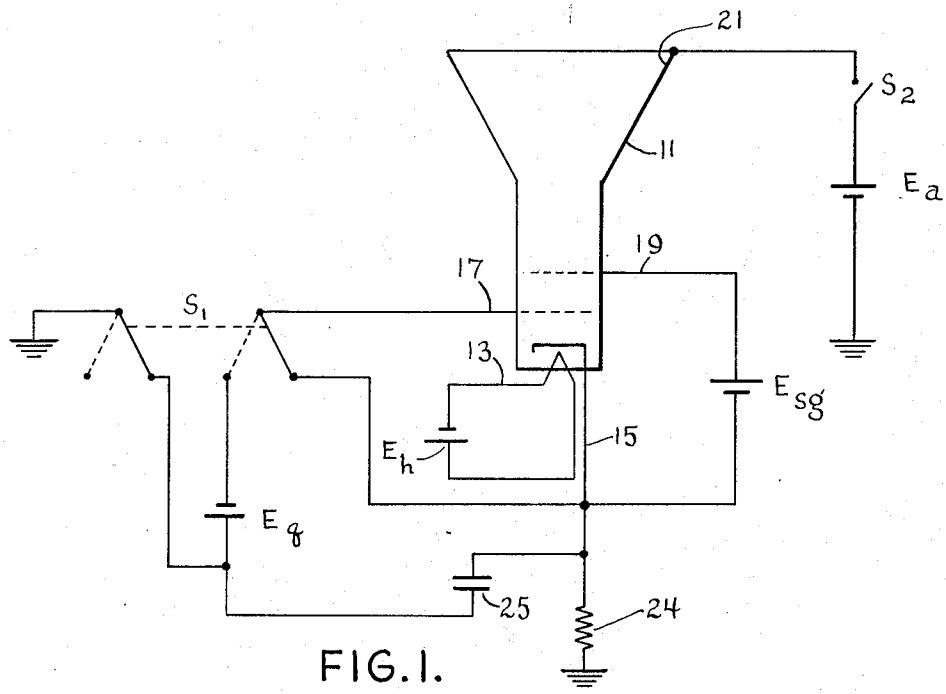


FIG. 1.

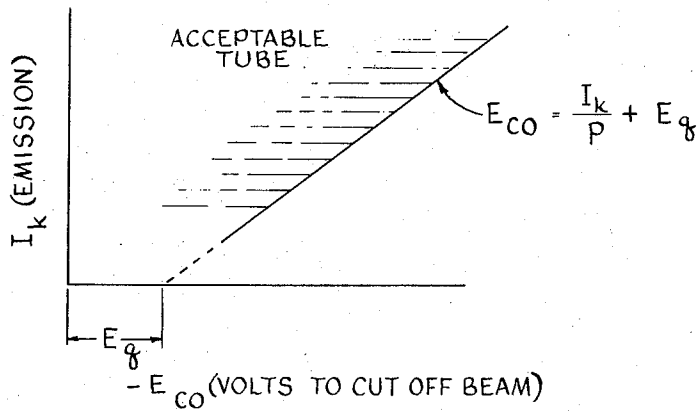


FIG. 2.

INVENTOR
ELMER O. STONE
BY
Robert E. Strauss
ATTORNEY

United States Patent Office

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ELECTRON DISCHARGE TUBE TESTING CIRCUIT

Elmer O. Stone, Seneca Falls, N.Y., assignor, by mesne assignments, to Sylvania Electric Products Inc., Wilmington, Del., a corporation of Delaware

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4 Claims. (Cl. 324—25)

This invention relates to test circuits and more particularly to an electrical circuit capable of measuring or indicating the cathode current cut-off characteristics of electron discharge devices such as cathode ray tubes.

A cathode ray tube undergoes a plurality of physical and electrical tests before it is approved by the manufacturer. When the cathode ray tube is of the type which is designated for operation as an image display device in a television receiver, one of the critical electrical tests which it must undergo occurs during determination of the value of control grid voltage necessary to cut off the beam current. It has been found that no exact value of grid bias voltage can be appropriately used to separate an acceptable tube from those which are not acceptable, since the grid cut-off voltage is dependent upon the electron emission characteristics of the tube.

Accordingly, an object of the invention is the evaluation of receiving tubes on the basis of cut-off characteristics which are formulated from cathode current characteristics.

A further object is the provision of a simple, efficient and accurate test for receiving tubes.

The foregoing objects are achieved in one aspect of the invention by the provision of a test circuit utilizing a source of potential, which is proportional to the cathode current of the tube under test, for purposes of establishing a grid bias voltage. If the current cuts-off at this bias, the tube is acceptable.

For a better understanding of the invention, reference is made to the following description, taken in conjunction with the accompanying drawings in which:

Fig. 1 is a schematic diagram of a cathode ray tube and its associated test circuit; and

Fig. 2 is a graphical representation of the grid cut-off voltage versus cathode current characteristics for a typical cathode ray tube.

Referring to the drawings, the graphical presentation indicates that the voltage required to cut-off the beam current of an acceptable cathode ray tube is proportional to the cathode current. The empirical formula which expresses this relationship may be stated as

$$E_{co}=\frac{I_k}{p}+E_q$$

where E_{co} is the grid voltage necessary to cut-off the cathode current, I_k, of an acceptable tube, and p and E_q are constants which apply generally to cathode ray tubes. These constants may vary somewhat in actual value for different types of cathode ray tubes. It is to be understood that the values expressed in the equation are generally negative in value.

The circuit diagram shown in Fig. 1 provides means for testing a given tube for its cut-off characteristics in accordance with the empirical relationship illustrated in Fig. 2. The cathode ray tube **11** is shown, for purposes of illustration, as having a heater **13**, cathode **15**, control grid **17**, screen grid **19** and an anode **21** which may be connected to the image display screen of the tube. A

direct current source E_h is provided for energization of heater **13** while direct current sources E_{sg} and E_a serve to supply the screen grid **19** and anode **21** respectively. A resistance **24** is coupled in series with the cathode to ground.

A switch S_1, which may be of the double pole, double throw type, operates to connect a cathode shunting capacitance **25** to ground in one position, and to control grid **17** in the other position. When switch S_1 is in the position shown by the dotted lines, capacitance **25** is serially connected with voltage supply E_q to grid **17**. It has been found that a satisfactory method of testing the control voltage beam current cut-off characteristic of a tube utilizes a value for I_k in the equation shown in Fig. 2 equal to the zero bias beam current of the tube. Accordingly, when switch S_1 is in the position shown, grid **17** is at cathode potential. However, it is to be understood that a cathode current other than zero bias current may be used if desired.

In operation, switch S_1 initially connects capacitance **25** to ground and control grid **17** directly to the cathode. The tube under test is then energized by closing S_2 so that zero bias beam current flows through E_a, tube **11**, and resistance **24**. An unknown voltage, which varies proportionally with the cathode current of the tube as shown by the graph, is developed across cathode shunting capacitance **25**. After this capacitance has been charged, switch S_1 is moved so that it serially couples capacitance **25** with the known direct current supply E_q in a boosting relationship to grid **17**. The tube is acceptable if the beam current cuts-off when the sum of these voltages contributed by capacitance **25** and E_q are connected to the control grid. Stated in terms of the equation, the tube is acceptable when E_{co} is equal to or less than

$$\frac{I_k}{p}+E_q$$

The screen of the tube may be observed to determine whether or not the beam current has been cut off.

Although the embodiment of the invention shown in the drawings is illustrated in conjunction with a cathode ray tube, it is to be understood that this type of circuit is also adaptable for use with receiving tubes other than cathode ray tubes. When testing a tube not provided with image display means, a meter could be used in the plate circuit of the tube to indicate the cathode current cut-off conditions.

Although one embodiment of the invention has been shown and described, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the scope of the invention as defined by the appended claims.

What is claimed is:

1. A test circuit for a grid controlled electron discharge tube comprising a voltage supply, means for developing a source of potential having a magnitude substantially proportional to the zero grid bias cathode current of the tube, and switching means for connecting said voltage supply and source of potential with the grid whereby the cathode current cut-off characteristic of the tube may be determined.

2. A test circuit for an electron discharge tube having a cathode, control grid and anode comprising a resistance coupled to the cathode, a capacitance normally shunting said resistance, means for energizing said tube to charge said capacitance in accordance with the cathode current in the tube, a voltage supply, and switching means for serially connecting said charged capacitance and voltage supply in boosting relationship with the control grid whereby the cathode current cut-off characteristic of the tube may be determined.

3. A test circuit for a grid controlled electron discharge

tube comprising a known voltage supply, means for developing an unknown source of potential having a magnitude substantially proportional to the cathode current of the tube, and switching means for connecting said voltage supply and source of potential to the grid whereby the cathode current cut-off characteristic of the tube may be determined.

4. A test circuit for a grid controlled electron discharge tube which, when acceptable, has a grid cut-off voltage equal to or less than

$$\frac{I_k}{p}+E_q$$

wherein I_k is the cathode current, E_q is a constant voltage supply for said grid, and T is a constant comprising means for developing a source of potential equal to I_k, a voltage supply equal to E_q, and means for serially coupling said voltage supply and said source of potential in a boosting relationship to the grid whereby the cathode current cut-off characteristic of the tube may be determined.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 2,947,936 August 2, 1960

Elmer O. Stone

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 3, lines 11 to 13, in the equation, after "I_k", strike out the minus sign; line 15, for "T" read -- p --; line 16, for "I_k" read -- $\frac{I_k}{p}$ --.

Signed and sealed this 11th day of April 1961.

(SEAL)
Attest:
ERNEST W. SWIDER
Attesting Officer

ARTHUR W. CROCKER
Acting Commissioner of Patents