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Y. IMAOKA

1,976,500

ELECTRIC DISCHARGE DEVICE

Filed Feb. 28, 1931

Fig. 1.

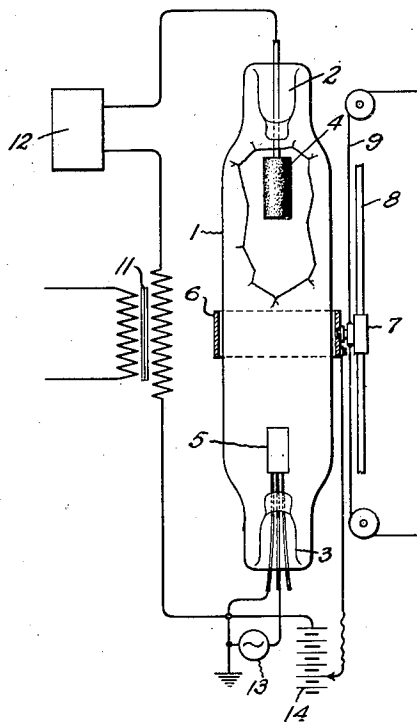


Fig. 2.

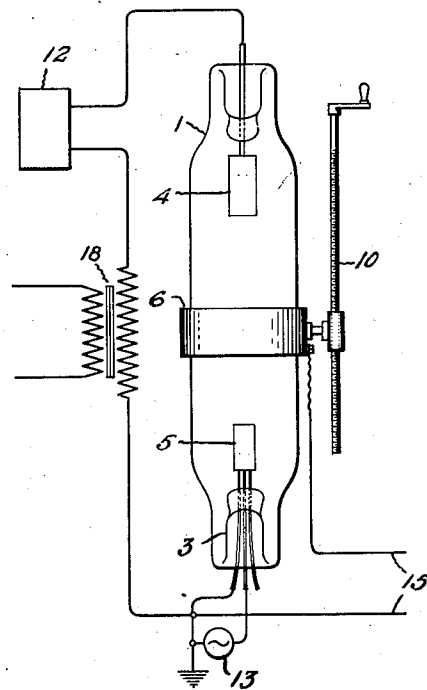
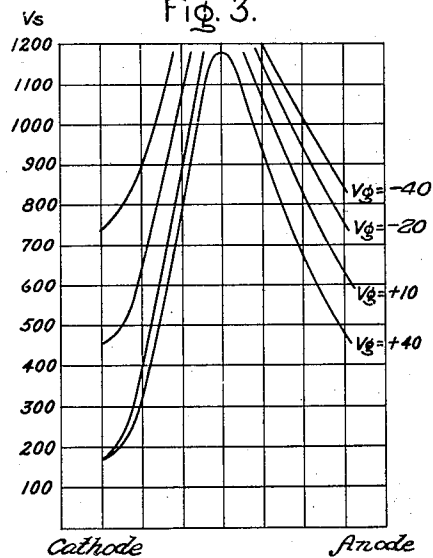


Fig. 3.



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UNITED STATES PATENT OFFICE

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ELECTRIC DISCHARGE DEVICE

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2 Claims. (Cl. 250—27.5)

The present invention relates to electric discharge devices containing gas or vapor in order to conduct considerable current and provided with a control member for initiating the discharge. A device of this type is usually designated electrostatically controlled arc discharge apparatus.

An object of the present invention is to provide a more accurate control of the initiation of the discharge in devices of this sort. A more specific object is to improve the control member and to provide an improved position of the member with respect to the discharge device and contained electrodes. These objects are attained in brief, by providing a control member external to the tube and which is adapted to be moved at will over the envelope, thereby to change its position with respect to the electrodes, as will be explained hereinafter. A control member of this sort is capable of accurately and reproducibly controlling the initiation of an arc discharge in the cathode-anode circuit. Other objects and features will be apparent as the specification is perused in connection with the accompanying drawing in which Fig. 1 shows, partly in diagram and partly in section, a tube provided with the improved grid and connected in a standard translating circuit. Fig. 2 shows a modified arrangement of moving the external control member, also a different form of circuit, while Fig. 3 shows a series of characteristics useful in explaining the electrical control exercised by the movable control member.

Referring to Fig. 1, numeral 1 designates an evacuated envelope of vitreous material containing an ionizable medium, for example, a fixed gas or vapor, at a pressure sufficient to support an arc discharge at ordinary operating voltages. The gaseous medium may consist of neon, argon, nitrogen or the vapor of caesium or similar alkali metals, or of mercury at pressures between a few microns to a few millimeters. The envelope terminates in oppositely directed reentrant stems 2, 3, the former of which supports an anode 4 which conveniently may take the form of a graphite cylinder. A cathode 5 of any suitable and well-known form, directly or indirectly heated, is mounted on the stem 3. This cathode may be coated with an electron-emitting substance such as alkaline earth material. External to the envelope, there is a hollow metallic cylinder or ring 6 which fits the envelope rather loosely and is adapted to slide over the latter so as to approach toward or recede from either

electrode. This ring is provided with a bearing or slide 7 which is adapted to slide over a rod guiding member 8 rigidly fixed in position. The force for moving the ring electrode 6 may be exercised through a pulley and belt arrangement 9 as shown in Fig. 1, or the bearing 7 may contain screw threads which cooperate with a manually operated screw 10 as shown in Fig. 2.

The electric discharge device is energized preferably through a voltage step-up transformer 11 from a source of alternating current energy, and the output circuit includes a load 12, conveniently shown as a rectangle. The voltage provided by the transformer ordinarily is just insufficient to initiate an arc discharge when the ring 6 is in its normal position or is at a normal bias potential. This position conveniently is midway between the electrodes. The load may constitute a relay or a multi-electrode tube connected in cascade to the discharge device 1 or any other form of load which responds to current flowing in said device. The cathode 5 may be energized by direct or alternating current, which source generically is indicated as an alternator 13 connected to ground. One side of the cathode is connected to one of the high voltage transformer terminals, and the other terminal of the transformer is connected to the load as shown. The electrode or control member 6 is adjustably connected to the common side of the cathode through a bias battery 14 or other source of direct current energy. In Fig. 2, the battery is replaced by a source of current whose value changes, as for example, a signalling circuit 15.

Referring now to Fig. 3, there are shown four representative curves for various positive and negative bias potentials applied to the control member 6, as indicated, and drawn against ordinates of voltage at which a given arc discharge will start, and against an abscissa which indicates relative positions of the movable control member along the envelope with respect to the electrodes. It will be noted that the starting voltage of the arc discharge is largest when the auxiliary electrode is nearly at its middle position, i. e. half-way between the anode 4 and the cathode 5. In general, when the grid voltage is negative with respect to the cathode, the value of the starting voltage is higher, and vice versa. It is therefore evident from a consideration of these curves that for a given tube and grid biasing potential, the position of the control member determines the voltage at which the arc discharge will start to flow between the elec-

rodes. The control member 6 thus offers a convenient method of "triggering" the arc discharge in that it can effectively control a change in output current which may be originally present simply as residual current, from a few micro-amperes to the full load current of many amperes. This full load current is determined not only by the conductivity of the tube which in turn is dependent upon the nature and pressure of gas and the spacing of electrodes but also upon the requirements of the load and the value of the applied voltage. A device of the type described has many applications in the art, for example, it may be used as a self-levelling device for elevators in which it is conceivable that the control member 6 and its bearing 7 may be secured to an elevator so that when the control member assumes a predetermined position on the envelope due to the position taken by the elevator, the arc discharge is "triggered" and the load which conveniently may be a relay, serves either to start or stop the elevator. Many other uses will occur to those skilled in the art.

In practice, the biasing battery 14 provides a sufficiently negative potential on the control member 6 that when the latter is in a predetermined position with respect to the inter-electrode space, which conveniently is midway, the arc is restrained from flowing at the plate voltage employed. However, when the control member moves away from this mid-position and approaches one or the other of the electrodes, the arc is initiated as may be observed from the graph.

In addition to offering a convenient method of controlling an arc by simply moving the member 6 over the envelope, the control member may also be employed for adjusting and calibrating the device for changes in ambient or operating temperatures which may alter the voltage at which the arc will start. Obviously, the control

member may be moved to a position on the envelope to permit the initiation of the arc at any and all envelope temperatures which affect and determine the pressure of the gaseous contents. Furthermore, the control member may be moved to a position such that the smallest change in anode voltage or in grid bias potential is sufficient to start the arc. Thus in Fig. 2, the position of the control member 6 is so regulated by the screw 10 that the smallest potential applied to conductors 15 is sufficient to "trigger" the device. This potential may be derived, for example, from a distant signalling station in which case the device 1 operates as an electrical relay which may actuate a relay load 12.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. An electric discharge device comprising an envelope containing an ionizable medium at a pressure sufficient to support an arc discharge at the operating voltages, a cathode and a cooperating anode, means for controlling the initiation of the arc, said means including a member adapted to be electrically charged movably mounted on the envelope and adapted to approach one electrode and to recede from the other electrode whereby the voltage at which the arc is initiated is changed.

2. An electric discharge device comprising an envelope containing an ionizable medium at a pressure sufficient to support an arc-like discharge at the operating voltages, a cathode and cooperating anode and means for restraining the arc discharge, said means consisting of a control member which is adapted to move along the exterior of the envelope between the cathode and anode and means for causing said control member to recede from one electrode and approach the other electrode whereby the voltage at which the arc is initiated is changed.

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