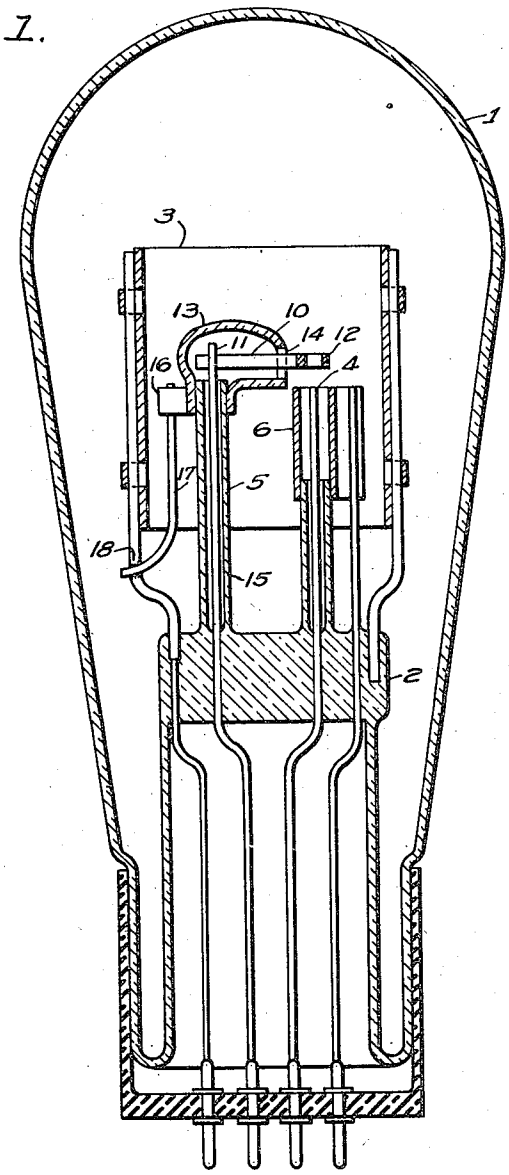
March 3, 1936. W. E. BAHLS 2,033,089

GRID GLOW TUBE

Filed Aug. 20, 1932 2 Sheets-Sheet 1

Fig. 1.



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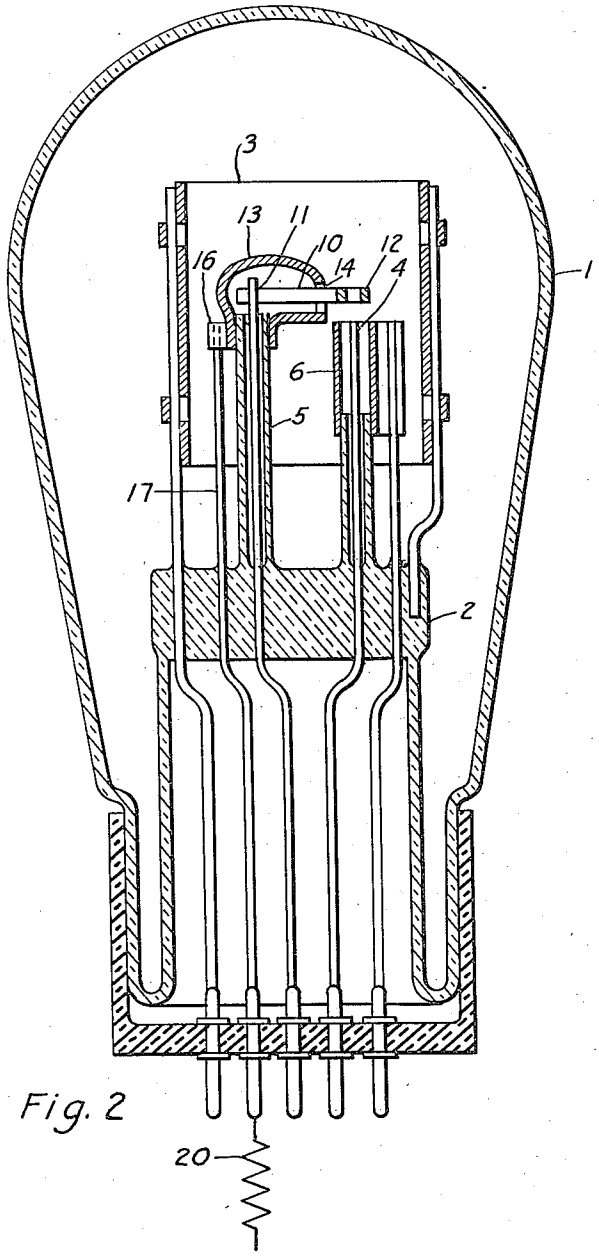

Fig. 2

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GRID GLOW TUBE

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Application August 20, 1932, Serial No. 629,657

8 Claims. (Cl. 250—27.5)

This invention relates to space-current devices, and particularly to that type of space-current apparatus in which an ionization current is controlled by a grid.

It is an object of my invention to render the operation of such devices more certain.

It is a further object of my invention to prevent a discharge between the cathode and any portion of the control electrode or its support except the portion which is directly depended upon for the control of the space current.

It is a further object of my invention to insert a barrier between the cathode and the support for the control electrode and thereby prevent a discharge from the cathode directly to said support.

It is a further object of my invention to provide a cap enclosing the portion of the grid support which extends above its sleeve and also enclosing the portion of the grid directly connected to said support.

It is a further object of my invention to prevent an arc or glow discharge reaching the welded connection between grid and grid support.

Other objects of my invention and details of the structure will be apparent from the following description and the accompanying drawings in which the Figure 1 is a vertical section of a grid-glow tube embodying my invention and Fig. 2 is a modification of Fig. 1.

A description of the grid-glow tube to which my invention has been applied and of the circuit with which such tube is used will be found in the application of Dewey D. Knowles, Serial No. 564,267, filed September 22, 1931, assigned to the Westinghouse Electric and Manufacturing Company.

My invention resides in the features herein described which have been added to the grid-glow tube disclosed in said application of Knowles, but it is not limited to this particular form of space current device. It may be added to any other forms of space current device and to other circuits.

In the drawings, an envelope 1 encloses a space which has been evacuated and filled to a small pressure with a suitable gas. The envelope is provided with a press 2 in which are mounted the cathode 3, anode 4, grid support 5 and anode shield 6, all of which are described in greater detail in said application of Knowles, and the detailed description thereof is not repeated here because my invention does not reside in any of these features.

Upon the grid support 5 a grid 10 is secured in any desired manner preferably by means of a weld indicated at 11. The portion of the grid 10 which extends to the weld 11 constitutes an arm supporting the ring-shaped portion 12 which is coaxial with the anode 4 and spaced a small distance therefrom. The ring 12 is the part of the grid which is relied upon to control the electrostatic field in the neighborhood of one end of the anode 4. The remainder of the grid serves only as a mechanical support and as a conductor to unite the ring 12 to the support 5 and, by the connection of this support through the press, with the external source of grid potential.

A shield or cap 13 surrounds the top of the grid support 5 and substantially all of the arm 10. An opening 14 in the shield 13 permits the arm 10 to project therethrough and thus permits the ring 12 to be located in its proper position.

The cap 13 is supported in any suitable manner. It may be mounted upon the upper end of the sleeve 15 which surrounds the grid support 5, either by means of friction or by providing a shoulder at the upper end of the sleeve. Another method of support, which I have chosen as the form for illustration, connects the cap 13 with the cathode 3. An ear 16 integral with the part of the cap which encloses the top of the sleeve is connected to a rod or wire 17 which is welded to one of the supports of the cathode, as shown at 18. When supported in this way, the cap must be of insulating material.

Instead of a direct connection between the cap 13 and the cathode 3, as in Fig. 1, the wire 17 may extend through the press as disclosed in Fig. 2 and provision may be made external to the tube for impressing a difference of potential between the cathode and the cap. The connection should also include a high resistance 20. When such provision for an externally impressed potential is made, the cap 13 should be of metal as illustrated in Fig. 2.

Another alternative is to support the cap by a lead similar to the lead 17, but extending to the support for the shield 6. The high resistance illustrated in the above-mentioned application of Dewey D. Knowles will then limit any current to or from the cap.

In the operation of the device, the tube is mounted in the usual way to constitute a part of a circuit by which a difference of potential is established between the anode 4 and the cathode 3. When this difference of potential is sufficient and is directed from the anode toward the

cathode, current will flow by an arc or a glow discharge between the two, provided the potential upon the ring 12 does not prevent. The circuit is so arranged that a potential is impressed through the standard 5 and arm 10 upon the ring 12.

The potential upon the grid must be positive relative to the cathode by more than a characteristic amount before the discharge between cathode and anode will occur. In some tubes to which this invention has been applied the anode is some 200 volts positive relative to the cathode and the tube will not become conductive unless the grid potential exceeds 384 volts relative to the cathode.

The circuit conditions are such that when the tube is to become conductive, a potential exceeding the characteristic potential is impressed upon the ring 12.

Heretofore, it has happened that, when the different of potential between the cathode 3 and the grid 12 was sufficient, a discharge occurred between the cathode and some portion of the grid other than the ring 12. Discharges from the cathode to the welded joint 11 are particularly likely to occur. The nature of the grid structure, particularly the materials chosen, and the nature of the gas conditions, particularly the kind of gas used, have an influence on the likelihood of such a discharge occurring.

If a discharge between the cathode 3 and the weld 11, or between the cathode and the grid support 5, or the arm 10, occurs, and in tubes not equipped with a shield 13, such discharges frequently occur, a much greater difference of potential between the anode 4 and the cathode 3 is required to shift the discharge from the grid to the anode than is necessary if the discharge between cathode and grid is to the ring 12. This change in the required value of the anode potential to transfer the discharge is the explanation of the erratic behaviour of such tubes under these conditions.

When a discharge occurs from the cathode to the ring 12, an anode potential very slightly greater than that sufficient to maintain a discharge between cathode and anode is sufficient to cause the prompt transfer of the discharge from the ring to the anode. In one tube, actually built and tested, in which 200 volts were required to maintain the discharge between cathode and anode, the tube remained non-conductive until the grid potential was 384 volts above the cathode. Then a discharge to the ring was transferred at once to the anode. In a similar tube without a shield 13, when the discharge became concentrated at the weld 11, the anode potential had to be increased to 700 volts above the cathode before the discharge would transfer to the anode.

When the housing 13 is provided, it presents a barrier separating the cathode 3 from the standard 5, the weld 11 and the arm 10. A discharge from the cathode to any of these parts is thereby prevented. A discharge directly from the housing 13 to any of these parts will not occur because the distance between the housing and any of them is smaller than the mean free path of the gas within the tube. A discharge from the cathode 3 through the opening 14 to the weld 11 or the parts united thereby is not possible because the opening 14 is too small for an ionization path to be established therethrough.

The housing thus ensures that the tube will not become conductive except by the occurrence of a discharge to the ring 12. When such a discharge occurs, it will transfer to the anode 4 immediately, provided the anode potential is slightly greater than that necessary to maintain the discharge and the tube thereafter conducts from anode to cathode in the regular way until the anode potential is reduced to a value which will not maintain the discharge.

When the source of potential in the circuit associated with the tube is alternating, the conductivity of the tube can be controlled by controlling the phase of the potential impressed upon the grid. In this way the moment within the positive half-cycle at which the tube will become conducting is controlled, and the average value of the current through the tube throughout the cycle is thus controlled. If discharges occur between the anode and the weld 11, as above described, the current through the tube will no longer have a predictable relation to the phase of the grid potential, but there will be transition points, that is, points of adjustment of grid phase at which the behavoir of the tube is different from that intended.

The introduction of the cap 13 prevents discharges to the weld 11 and the welded parts and thus prevents such transition points.

My invention is capable of many modifications which will readily occur to those skilled in the art. For example, the cap 13 may be made of insulating material as in Fig. 1 or of conducting material as in Fig. 2, and when conducting, a control potential may be impressed upon it. The omission of specific mention of such modifications is not to be regarded as indicating an intentional limitation. The only limitations intended are those required by the prior art or indicated in the accompanying claims.

I claim as my invention:

1. In a grid-glow tube, a control-electrode support, a control-electrode comprising a member in effective position for control of the space-current and an arm whereby said member is supported from said control-electrode support, and a cap mounted over said support and surrounding said arm in closely spaced relation thereto.

2. A control-electrode assembly comprising a conductive support, a sleeve enclosing said support, an arm secured at one end to said support and a cap enclosing said arm except a portion at its free end.

3. A control-electrode assembly comprising a conductive support, a sleeve enclosing said support, an arm secured at one end to said support, a ring on the free end of said arm and a cap enclosing said arm except for the free end containing said ring.

4. A control-electrode assembly comprising a conductive support, a sleeve enclosing said support, an arm secured at one end to said support, a ring on the free end of said arm and a cap support on said sleeve enclosing said arm except for the free end containing said ring, said support, arm and ring being insulated by said cap and sleeve.

5. A gaseous discharge device comprising an anode, a cathode, a control electrode having a portion adjacent said anode, and a conductive shield about the exposed portion of said control electrode not included in the first-mentioned portion adjacent said anode.

6. A gaseous discharge device comprising a pointed anode, a cathode of large area surrounding said anode, a control electrode intermediate said anode and cathode and having a portion ad-

jacent said anode and a conductive shield about the exposed portion of said control electrode not included in the first-mentioned portion adjacent said anode.

7. An electric discharge device comprising a container, an anode, cathode and control electrode therein, said control electrode having an effective portion closely adjacent said anode and a shield spaced from said control electrode but closely surrounding the control electrode except for the effective portion thereof adjacent said anode.

8. An electric discharge device comprising a container having a gaseous medium therein, a first electrode, a second electrode, a third electrode, intermediate in position between said first and second electrode, an auxiliary electrode enveloping the major portion of said first electrode and an auxiliary shield screening all except a small portion of said third electrode from all the other said electrodes.

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