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RECTIFYING TUBE

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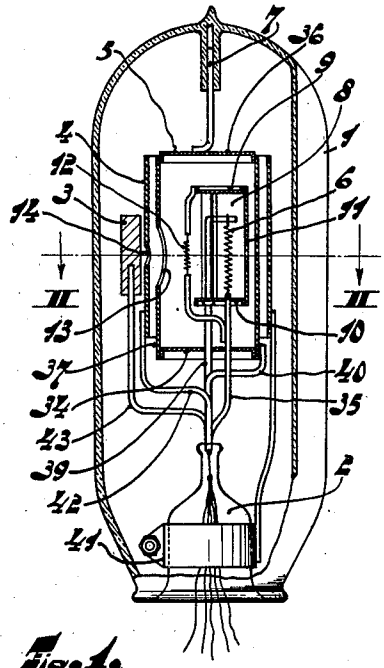

Fig. 1.

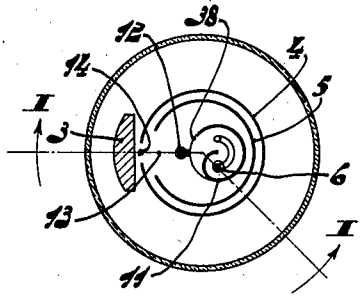

Fig. 2.

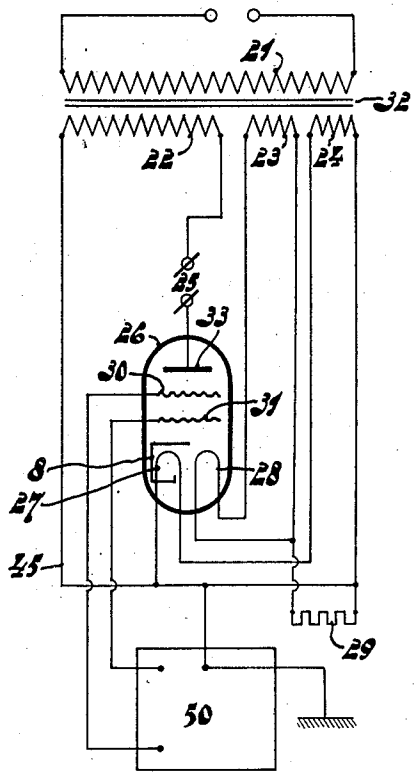

Fig. 3.

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RECTIFYING TUBE

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5 Claims. (Cl. 250—27.5)

My invention relates to grid-controlled ionic rectifying tubes having an activated incandescible cathode.

By an "ionic rectifying tube" is meant a rectifying tube whose filling comprises one or more gases, vapors, or a mixture thereof.

Such tubes are usually of a very compact construction in which the control grids substantially concentrically surround the incandescible cathode and are provided with apertures through which the discharge may pass from the cathode to an anode or plate located outside the grids.

With such a construction, there is considerable difficulty due to the fact that the disintegrated emitting substance emanating from the incandescible cathode deposits upon the grid surface, especially in the vicinity of the apertures. More particularly, due to this deposition of the emitting substances, the characteristic ignition voltage-grid voltage curve, i. e. the "ignition characteristic" of the tube, varies, and the minimum grid voltage necessary to prevent ignition of the tube at a definite anode voltage will greatly vary during the normal life of the tube.

Furthermore, when the anode current is increased at a definite value of the anode voltage, the minimum negative grid voltage required to interrupt a large anode current is different and higher than that required to interrupt a small anode current. This may be true to such an extent that it is impossible even at an optionally high negative grid voltage, to prevent the passage of the anode current, and as a result the tube will allow the continuous passage of the anode current and its relay function will cease. The above irregular operating conditions appear to be due to secondary emission from the deposits of cathode material upon the surface of the highly heated control grids.

The object of my invention is to overcome the above-mentioned difficulties and for this purpose I so shield the main incandescible cathode from the surrounding grid by means of an apertured metal screen that the particles emanating from the cathode cannot pass from the cathode in a straight line to strike the grid. Furthermore, to facilitate the ignition of the discharge, I provide outside the screen and in the vicinity of the aperture therein, a preferably unactivated auxiliary incandescible cathode, which is electrically connected to the main cathode.

The auxiliary cathode serves to initiate the discharge to the anode at the beginning of each alternating current half-cycle which the relay-tube allows to pass, whereupon the activated main cathode, due to its higher emitting capacity, assumes the emission function. Such an arrangement has the advantage that the control action of the grids cannot be rendered irregular by an accumulation of emitting particles thereon, and that the auxiliary cathode, due mainly to the absence of activated substances thereon, assures regular initiation of the ignition.

To simplify the construction of the tube, as well as its circuit arrangement, I connect the auxiliary cathode in parallel with the main cathode, whereby the internal connections of the tube may be so made that one end of the main cathode, one end of the auxiliary cathode, as well as the metal screen, form one terminal of the heating circuit. Thus it is possible, without additional means, to secure one end of one or both of the cathodes to the metal screen as a connecting terminal.

To facilitate transition of the discharge from the auxiliary cathode to the main cathode I prefer to feed the auxiliary cathode and the main cathode from separate current sources which are connected through a resistance. In this case, upon striking of a discharge between the auxiliary cathode and the anode the emission current of the auxiliary cathode will produce in the resistance a voltage drop which causes the voltage difference between the anode and the auxiliary cathode to be less than that between the anode and the main cathode. By giving this resistance such a value that the auxiliary-cathode emission current is limited, not only is a detrimental loading of the auxiliary cathode prevented, but in addition the tendency of the discharge to pass from the auxiliary cathode to the main cathode is greatly increased.

In one embodiment of my invention, I construct the metal screen enclosing the main cathode of a spiral-shaped sheet-metal member closed at its ends by disc shaped members. Such a screen is simple in construction and provides an internal shielded chamber for the cathode as well as an aperture for the passage of the discharge.

In order that my invention may be clearly understood and readily carried into effect, I shall describe same more fully with reference to the accompanying drawing, in which:

Figure 1 is a sectionized side view of a rectifying tube according to the invention taken on the line 1—1 of Fig. 2;

Fig. 2 is a sectionized view of the tube Fig. 1 taken along line 2—2;

Fig. 3 is a schematic circuit arrangement in-

cluding an ionic rectifying tube according to the invention.

The ionic rectifier tube shown in Figures 1 and 2 comprises an envelope 1 containing an anode or plate 3, two control grids 4 and 5, a main incandescible cathode 6, an auxiliary incandescible cathode 12, and a cathode screen 8.

The main cathode 6 is of the activated type, being coated with a substance such as barium oxide, and has its lower end connected to a lead-support 35 sealed in the pinch 2, whereas its upper end is connected to the screen 8.

The screen 8 surrounds the main cathode 6 and comprises a spirally-wound sheet-metal member 11 forming an aperture 38 for the passage of the discharge, and two disc-shaped end members 9 and 10. The aperture 38 is of such a width that the cathode screen, relatively to the control grids, does not appreciably influence the ignition of the tube. The screen 8 is suitably supported from pinch 2 by means of a support-lead 39.

The auxiliary cathode 12, which is preferably of the unactivated type, is disposed in the vicinity of the aperture 38, and has its upper end connected to the screen 8 and its lower end connected to the support 35, whereby it is connected in parallel with the cathode 6.

Surrounding the cathodes 6 and 12 and the screen 8 is the control grid 5 supported from the top of the envelope by a rod 7 and comprising a cylindrical metal member 37 having an aperture 13 of 10.5 mm. diameter and two disc-shaped end members 5 and 34. A lead 40 serves as the electrical connection to the grid 5.

Surrounding the grid 5 is the grid 4 of cylindrical shape and provided with an aperture 14 of 3.5 mm. diameter. The grid 4 is supported from pinch 2 by means of a clamp 41 and is provided with a lead 42 sealed in the pinch 2.

The anode or plate 3 is supported from pinch 2 by means of a lead-support 43.

From Figs. 1 and 2 it appears that particles of activating substance emanating from the main cathode 6 cannot possibly pass beyond the internal surface of the cathode screen 8, but are interrupted thereby, in which case the apertures 13 and 14, which are determinative for the control, as well as the surrounding portions of the grids 4 and 5, remain permanently free from emitting substance. Due to this, and to the constant operation of the unactivated auxiliary cathode 12, regular operation of the rectifying tube is insured throughout its life.

The tube shown in Figures 1 and 2, which is drawn to scale, has a diameter of about 38 mm., a heating voltage of 2 volts, and a heating current of 2.8 amperes, and is capable of withstanding a maximum load of 170 volts A. C. anode voltage and 1.2 ampere arithmetical mean anode current. The tube is primarily adapted for use as a switching tube in relay-arrangements, it being possible either to control the anode circuit of the tube by means of the two grids 4 and 5 from two different circuits, or the inner grid 5 may be used as a control grid and the outer grid 4 may be used as a screen grid for reducing the internal grid-anode capacity. In many cases it may be useful to connect the inner grid 5 to the cathode 6 and to use the outer grid 4 as a control grid.

The characteristic curve of a rectifying tube according to the invention is substantially independent of the life of the tube. A practical application of such a tube may be for operating a time switch, the tube periodically allowing for 1 second the passage of a current having a r. m. s. value of ½ amp. and the grid voltage preventing the ignition being shifted at the most by 0.03 volt after 20,000 switching operations at a constant anode voltage. At the same time it is found that at a constant anode voltage the above "critical" grid voltage depends to a much smaller degree on the value of the anode current than with the tubes of prior constructions.

The circuit arrangement shown in Fig. 3 comprises a transformer 32 and a rectifier tube 26, similar to the tube shown in Figs. 1 and 2, and having an anode 33, a main cathode 27, an auxiliary cathode 28, and two grids 30 and 31.

The transformer 32 is provided with a primary winding 21 connected to an alternating current source (not shown), a main secondary winding 22, and two auxiliary windings 23 and 24 for heating the cathodes 27 and 28 respectively. The secondary winding 22 has one end connected through a load 25 to the anode 33, whereas its other end is connected through conductor 45 to one end of the cathode 27.

The winding 23 is connected across the auxiliary cathode 28, whereas the winding 24 is connected across cathode 27. Connected between the auxiliary windings 23 and 24 is a resistance 29 of 10,000 to 100,000 ohms which serves to limit the emission current of the auxiliary cathode 28 and thereby—after the discharge has been struck at the auxiliary cathode—promote its passage to the main cathode 27.

The control grids 30 and 31, as well as one end of the main cathode 27, are connected to an optional source of potential, indicated by 50, which serves to arbitrarily control the operation of the main circuit of the rectifying tube 26.

Any flow of anode current in the tube 26, with anode tensions up to 170 volts r. m. s. may be prevented by the application of −10 volts D. C. to grid 31 (grid 5 of Figs. 1 and 2) or of −30 volts D. C. to grid 30 (grid 4 of Figs. 1 and 2) with respect to the main cathode 27 (cathode 6 of Figs. 1 and 2).

While I have described my invention in connection with specific examples and applications, I do not wish to be limited thereto but desire the appended claims to be construed as broadly as permissible in view of the prior art.

What I claim is:

1. An ionic rectifying tube comprising, an envelope, a control grid, an anode, an activated incandescible main cathode, a metal screen disposed between said main cathode and anode to prevent the particles emanating from the cathode from passing in a straight line to the anode, said screen being provided with an aperture for the passage of a discharge between said main cathode and anode, and an auxiliary incandescible cathode disposed in the vicinity of said aperture and outside said screen.

2. An ionic rectifying tube comprising, an envelope, a control grid, an anode, an activated incandescible main cathode, a metal screen disposed between said anode and cathode to intercept the particles emanating from the cathode, said screen being provided with an aperture for the passage of the discharge, and an auxiliary unactivated incandescible cathode disposed outside said screen and in the vicinity of said aperture, said auxiliary cathode being electrically connected in parallel with said main cathode.

3. An ionic rectifying tube comprising, an envelope, a control grid, an anode, an activated incandescible cathode, a metal screen surrounding said cathode to intercept the particles emanat-

ing from the cathode, said screen comprising a spiral-shaped sheet metal member forming an aperture for the passage of the discharge from the cathode to the anode, and sheet metal end members, and an auxiliary incandescible cathode disposed outside of said screen and in the vicinity of said aperture.

4. An ionic rectifying tube comprising, an envelope, a control grid, an anode, an activated incandescible main cathode, a metal screen disposed between said anode and cathode to intercept the particles emanating from the cathode, said screen being provided with an aperture for the passage of the discharge, and an auxiliary incandescible cathode disposed outside said screen and in the vicinity of said aperture, one end of each of said cathodes being electrically connected to said screen.

5. An ionic rectifying tube comprising an envelope, a control grid, an anode, an activated incandescible cathode, a metal screen surrounding said cathode to intercept particles emanating from the cathode, said screen comprising a sheet metal member in the shape of one turn of a spiral and forming an aperture for the passage of the discharge from the cathode to the anode, and sheet metal end members, and an auxiliary incandescible cathode disposed outside said screen and in the vicinity of said aperture.

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