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RECTIFYING DEVICE

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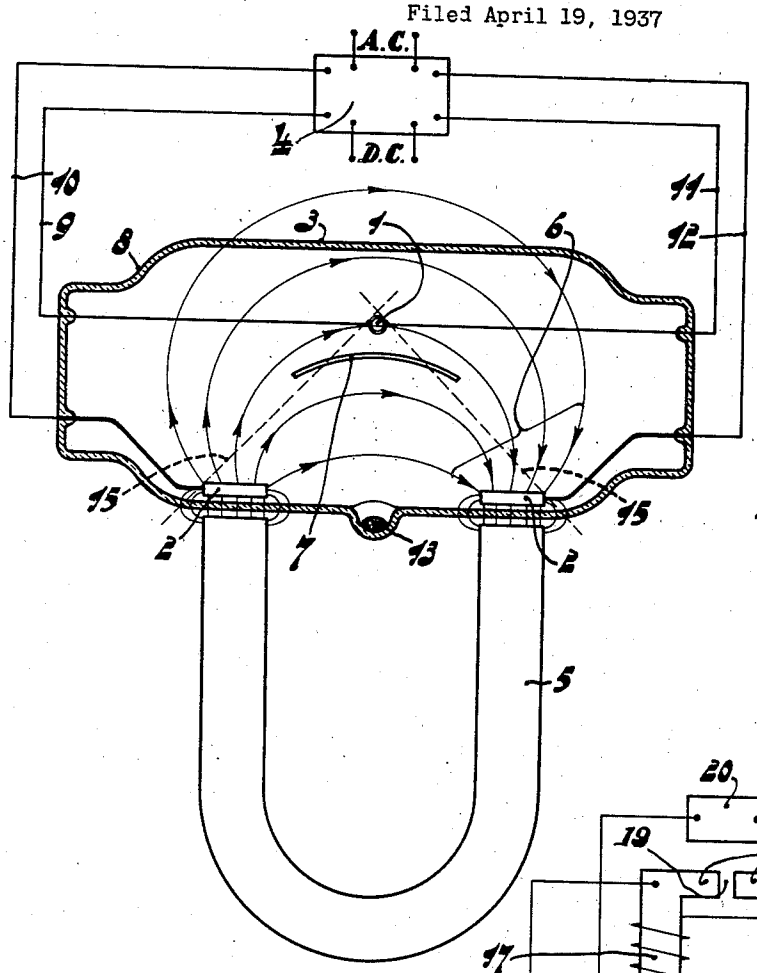


Fig. 1.

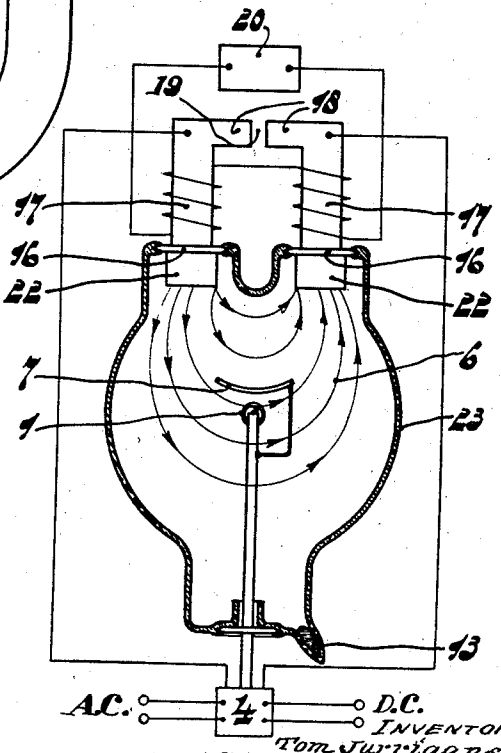


Fig. 2.

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RECTIFYING DEVICE

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8 Claims. (Cl. 250—27.5)

My invention relates to A. C. rectifying devices, and more particularly to devices comprising an incandescible-cathode ionic rectifying tube.

My invention is particularly advantageous in connection with the rectification of A. C. current of medium voltages, having an inverse peak value of about 150–1000 volts and for currents of from several amperes to 100 amperes or more; however it is not limited thereto, but may be used in connection with other voltages and currents.

It is, of course, essential to prevent back discharges in gaseous rectifying tubes, i. e. tubes having a filling of one or more gases, vapors, or a mixture thereof, and much work has been done in this direction, especially in connection with mercury-cathode tubes. Although the use of a gaseous filling at low pressure, for instance 0.01 mm. of Hg or less, will prevent such discharges, this results in a very high voltage drop in the discharge path, which reduces the life of the tube. More particularly, in incandescible-cathode tubes, the life of the cathode is materially reduced by ionic bombardment due to the high voltage drop in the discharge path, and the cathode had to be made oversize to ensure reasonably long life. On the other hand, if the filling is given a high pressure, for instance 1 mm. of Hg or more, to increase the tube life, back discharges will occur at high anode voltages, for instance at voltages of 100 volts R. M. S. or more. As a result of the above conflicting requirements, the pressure of the gaseous filling has generally been given a compromise value which fully met the essential condition of preventing back discharges at the expense of a reduced life of the tube.

The object of my invention is to eliminate the above difficulties and to remove the undesirable effect of a low-pressure filling upon the life of the tube, while retaining its protective effect against back discharges.

In accordance with the invention, I use an incandescible-cathode rectifying tube having a gaseous filling at a pressure of less than 0.01 mm. of Hg even at the emitting surface of the cathode, and provide within the tube a magnetic field whose lines of force connect the anode and cathode.

With such a construction the protection against back discharges is not appreciably reduced, whereas the possibility of ionization for the discharge is greatly increased in the direction of current flow; due probably to the extension of the electron paths through the magnetic field whereby the possibility of electrons colliding with neutral gas molecules or gas atoms is greatly increased. This appears from the fact that there is a decrease in the cathode drop whereby the disintegration of the cathode is reduced and thus the life of the tube is materially increased. As the cathode drop generally constitutes the main portion of the total voltage drop of the discharge, thus phenomenon is of especial importance.

It is preferable that the discharge path follow as closely as possible the lines of force of the magnetic field, as I have found that a considerably larger voltage drop will occur in the discharge at any point at which the path is caused to deviate from the magnetic lines of force. Furthermore, I prefer to so arrange the electrodes in the magnetic field that substantially the entire discharge path extends within that part of the discharge space which is traversed by the magnetic lines of force. In this manner the efficiency of the arrangement is increased to the maximum, whereas a minimum amount of magnetic energy is required.

In one embodiment of my invention, as applied to a full-wave rectifying tube, I so arrange the magnetic field that the lines of force traverse the tube envelope at two definite points at which the anodes are disposed, whereas I locate the cathode in the center of the magnetic beam extending between these points, so that the discharge path extends in the direction of the magnetic lines of force. In such arrangement the means for producing the magnetic field can be very advantageously provided outside of the tube, and the magnetic field can be readily concentrated at the desired points of the envelope.

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:

Figures 1 and 2 are partly sectionized views of full-wave rectifying devices according to the invention.

The device illustrated in Fig. 1 comprises a full-wave rectifying tube 3, a permanent magnet 5, and a rectifying circuit arrangement indicated by 4 and having single-phase A. C. supply terminals and D. C. output terminals.

The tube 3 comprises a closed envelope 8 of vitreous material, an incandescible cathode 1, energized in a suitable manner not shown, and two anodes 2 in the form of metal discs, for instance of iron, adjacent the envelope. Cathode 1 and anodes 2 are connected to arrangement 4 by means of conductors 9 to 12, and as such rectifying circuits are well known in the art,

further description of same is believed unnecessary.

Tube 3 is provided with a suitable gaseous filling, for instance mercury vapor, having during operation a pressure of less than 0.01 mm. of Hg. As shown, a quantity of mercury 13 is provided in a protuberance, formed preferably in a cool portion of the envelope. In some instances it is preferable to artificially cool the portion of the envelope in which the mercury is disposed, for instance by a circulating cooling liquid, in order to maintain the mercury at a temperature which agrees with the corresponding saturation pressure of the mercury vapor within the tube. As such cooling means are well known in the art and do not form part of the present invention, further description or illustration of same is believed to be unnecessary.

Disposed outside tube 3 with its pole faces in contact with the outer surface of envelope 3 and in line with anodes 2, is a permanent magnet 5. Magnet 5 produces a constant magnetic field whose lines of force extend within the tube between anodes 2, as indicated by the arrowed lines 6. It will be noted that cathode 1 is disposed centrally within this magnetic field, and that the discharge path between cathode 1 and anodes 2 closely follows the lines of force of this field.

It will be noted that cathode 1 extends perpendicularly to the lines of force, and thus is intercepted by a maximum number of lines of force, which insures a minimum voltage drop of the discharge. Furthermore, the lines of force extending between the anodes 2 are located in a space which is materially free from any obstruction which might impede the passage of the discharge along the lines of force extending from the cathode to each anode.

To prevent the possibility of back discharges being caused by particles disintegrating from cathode 1 and dropping on the anode 2, a screen 7 of non-magnetic material such as molybdenum intercepts straight lines drawn from any point on the cathode to the anodes. Two such lines are indicated by 15.

It will be noted that the screen 7 is curved to follow the direction of the lines of force, and thus intercepts only a minimum number of the lines.

Although in Figure 1 a constant magnetic field as produced by a permanent magnet has been shown, an electromagnet may also be used. This is shown in Figure 2 in which the same reference numbers have been used to designate the parts corresponding to those of Figure 1.

In contradistinction to Figure 1 the anodes 22 are not supported by separate anode supports but they are directly welded to circular ferrochromium discs 16 forming part of the envelope 23 of the tube. The two legs 17 of the electromagnet are welded to the discs 16 and serve at the same time as lead-in conductors to the anodes 22. The magnetic circuit is completed by pole pieces 18 having a gap 19 between them which prevents the setting up in the glass envelope of thermal stresses which might damage the tube and insulates the two anode leads from each other.

The electromagnet windings are connected to a current supply 20 shown schematically and providing the electromagnet with direct or alternating current according as to whether a constant or a pulsating magnetic field is desired.

In fact it is immaterial in what direction the magnetic field may pulsate, provided it disappears only at the moments at which it can be dispensed with for suitable operation of the tube.

Under some conditions it is of advantage to use a magnetic field which pulsates with the anode current in such a manner that the magnetic field disappears during the blocking phase of the anode and thereby insures maximum protection against back discharges.

The tubes shown in the figures of the drawing may be used to rectify alternating currents up to of the order of 1–50 ampere at negative peak voltages of approximately 150 volts or higher.

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. A full-wave rectifying device comprising an ionic discharge tube having an envelope, an incandescible cathode, two anodes disposed adjacent the wall of the envelope, and a gaseous filling having during operation a pressure less than 0.01 mm. of mercury, and means outside the envelope to produce a magnetic field having lines of force traversing the envelope at points adjacent the anodes and extending between the anodes in a beam, said cathode being centrally disposed within said beam and spaced from said anodes to form a discharge path following the lines of force thereof.

2. A full-wave rectifying device comprising an ionic discharge tube having an envelope, an incandescible cathode having a main emission surface, two anodes disposed adjacent the wall of the envelope, and a gaseous filling having during operation a pressure less than 0.01 mm. of mercury, and means outside the envelope for producing a magnetic field having lines of force traversing the envelope at points adjacent the anodes and extending between the anodes in a beam, said cathode being centrally disposed within said beam with the main emission surface extending transversely to lines of force thereof and being spaced from said anodes to form a discharge path following the lines of force.

3. A full-wave rectifying device comprising an ionic discharge tube having an envelope, an incandescible cathode, two anodes disposed adjacent the wall of the envelope, and a gaseous filling having during operation a pressure less than 0.01 mm. of mercury, and means outside the envelope to produce a magnetic field having lines of force traversing the envelope at points adjacent the anodes and extending between the anodes in a beam, said cathode being centrally disposed within said beam and spaced from said anodes to form a discharge path following the lines of force thereof and lying substantially entirely within the portion of the discharge space traversed by the lines of force.

4. A full-wave rectifying device comprising an ionic discharge tube having an envelope, an incandescible cathode, two anodes disposed adjacent the wall of the envelope, said cathode being spaced from each anode by a distance substantially equal to the distance between the anodes, a screen between said cathode and anodes and located symmetrically with respect to a line passing through said anodes, and a gaseous filling having during operation a pressure less than 0.01 mm. of mercury, and means outside the envelope to produce a magetic field having lines of force traversing the envelope at points adjacent the an-

odes and extending between the anodes in a beam, said cathode being centrally disposed within said beam to form a discharge path following the lines of force thereof.

5. A full-wave rectifying device comprising an ionic discharge tube having an envelope, two anodes disposed adjacent the wall of the envelope and substantially in a common plane, an incandescible cathode disposed above said plane and symmetrically with respect to said anodes, a screen between said cathode and said plane and located symmetrically with respect to said anodes, said screen intercepting a straight line between any point on said cathode and any point on said anodes, and a gaseous filling having during operation a pressure less than 0.01 mm. of mercury, and means outside the envelope to produce a magnetic field having lines of force traversing the envelope at points adjacent the anodes and extending between the anodes in a beam, said cathode being centrally disposed within said beam and spaced from said anodes to form a discharge path following the lines of force thereof.

6. A full-wave rectifying device comprising an ionic discharge tube having an envelope, two anodes disposed adjacent the wall of the envelope and substantially in a common plane, an incandescible cathode disposed above said plane and symmetrically with respect to said anodes, a screen between said cathode and said plane and located symmetrically with respect to said anodes, and a gaseous filling having during operation a pressure less than 0.01 mm. of mercury, and means outside the envelope to produce a magnetic field having lines of force traversing the envelope at points adjacent the anodes and extending between the anodes in a beam, said cathode being centrally disposed within said beam and spaced from said anodes to form a discharge path following the lines of force thereof, said screen being curved to follow the lines of force.

7. A discharge tube having electrodes including a cathode, and an envelope having a vitreous portion and metal members sealed therein, and means for producing a magnetic field within said envelope comprising a coil and a core having two portions insulated from each other, each of said portions having one end secured to one of said members.

8. A full-wave rectifying device comprising an ionic discharge tube having an envelope comprising a vitreous portion and two metal members sealed therein, an incandescible cathode, two anodes each secured to one of said metal members, and a gaseous filling having during operation a pressure less than 0.01 mm. of mercury, and means outside the envelope for producing a magnetic field having lines of force passing through said metal members and anodes and extending between the anodes in a beam, said cathode being centrally disposed within said beam and spaced from said anodes to form a discharge path following the lines of force, said means comprising a coil, and two cores electrically insulated from each other, each core having one end secured to the outer surface of one of said metal members.

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