

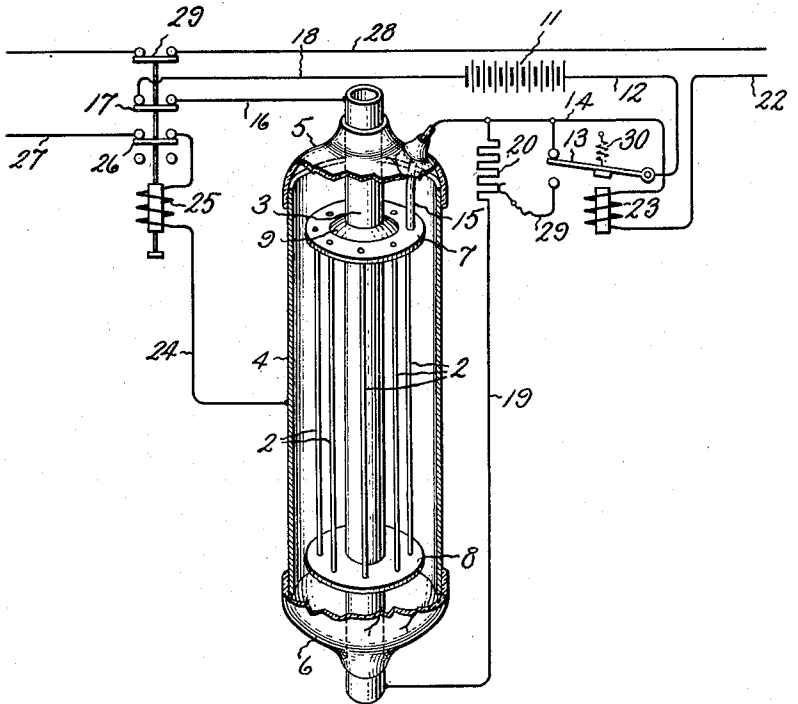
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W. E. PAUL

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ELECTRON DISCHARGE APPARATUS

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UNITED STATES PATENT OFFICE

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ELECTRON-DISCHARGE APPARATUS

Application filed October 10, 1925. Serial No. 61,759.

The present invention comprises an electron discharge device which, while adapted for various uses, is particularly well adapted for use as a circuit breaker in power circuits.

5 It is the object of my invention to provide a device whereby relatively large currents can be conducted efficiently, which device also is capable of use as a rectifier and where-
10 by also in case of a dangerous rise in current the circuit may be interrupted with rapidity by the action of a magnetic field.

While the novel features of my invention are pointed out with particularity in the appended claims, it should be understood at
15 this point that my invention includes the following features:

First: It provides a discharge device containing within itself a conductor whereby a magnetic field capable of controlling the
20 electron or space current may be generated by a current traversing the conductor which is independent of the cathode heating current.

Second: It provides a discharge tube of
25 novel construction whereby the magnetic field of the cathode current which opposes electronic conduction is neutralized by a counter-magnetic field generated by the current returning through an axial conductor,
30 in this manner reducing the current limitation due to magneto-strictive effect.

Third: It provides an arrangement of elements whereby in case of a short-circuit, or
35 similar line disturbance, a sufficiently large current may be passed through a conductor within the discharge tube, but distinct from the electrodes, to open the circuit by magneto-striction.

40 These novel features may be better understood from the following detailed description taken in connection with the accompanying drawing. The latter shows somewhat diagrammatically an electron tube embodying my invention with the wall in part

removed, and includes suitable circuit connections for operating this device.

The device here shown comprises a sealed container, preferably evacuated, in which are provided a cathode 2 constituted of a plurality of conductors connected in parallel and
50 grouped about a central tubular conductor 3 consisting of copper or other suitable metal. The anode is constituted by a part of the container wall 4 which consists of nickel or other
55 metal and is sealed to the tube 3 by sections or caps of glass as indicated at 5 and 6. If desired, suitable cooling fluid may be circulated through the conductor 3 and the external electrode 4 may be cooled by any well
60 known method.

The cathode wires are connected in parallel to the metal rings 7, 8, and grouped in the form of a revolutes about the conductor
65 3. The ring 7 is mounted on the tube 3 by an insulating support 9, consisting of quartz, or other suitable material, the ring 8 being mounted directly upon the tube 3.

A heating current is conveyed to the cathode conductors from a suitable external
70 source, such as the battery 11, by the conductor 12, the switch arm 13, the conductor 14, the sealed-in lead 15, the axial tube 3, the conductor 16, the switch blade 17 and the conductor 18.
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To assure a neutral magnetic field between the cathode members and the anode, a shunt circuit 19, containing an adjustable resistance
80 20, may be provided in parallel with the cathode. As the tube 3 carries both the cathode current and the current in the shunt circuit 19, the magnetic field of the current in this return circuit in 3 is greater than that due to the cathode current, thus effectively neutralizing the field in the electron path. How-
85 ever, this added current is not always necessary, and if not needed the resistance 20 may be omitted.

The power current is carried from the conductor 22, through a magnet coil 23 to the
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cathode 2, by electrons across the vacuous space to the anode 4, from thence by a conductor 24, to the holding coil 25 of a switch 26 to the opposite conductor 27 of the line. The return wire of the power circuit shown at 28 has included in it a switch 29 which is operated by mechanism in common with the switch 26.

If a destructive short circuit should occur on the power lines 22, 28 and the series coil 23 were merely to open the circuit by pulling down its armature 13, thereby opening the cathode circuit, then the cathode conductors, because of their substantial mass, would stay hot enough to emit electrons for perhaps several seconds. This would maintain a destructive current in the short circuit of the lines 22 and 28 for a prohibitive length of time. In accordance with my invention the operation of the coil 23 not only opens the cathode circuit but by the closure of a circuit through the conductor 29 by the switch arm 13, completes a circuit from the current source 11 through the length of the copper tube 3. As this copper tube has a very low resistance a very large current flows from the source 11, thereby producing a sufficiently strong magnetic field to instantly interrupt the electron circuit by magnetostriction. The operation of a radial magnetic field in interrupting the electron circuit is described in Hull Patent #1,523,778, issued January 20, 1925, with respect to a device in which the magnetic field is produced by the cathode heating current. In the present case the action is analogous except that the magnetic field is produced by current flowing through an axial conductor which constitutes part of the cathode circuit when the electron tube is operating, but does not itself function as cathode. As soon as the current in the line is interrupted by the action of the magnetic field the coil 25 releases its armature, opening the switches 26, 29, which deenergizes both the main line and the battery current, thus rendering the entire circuit inoperative. Spring 30 connected to the switch arm 13 returns the switch arm to its original position, closing the circuit from the battery to the cathode. The device may be put into service again by raising the armature of the coil 25, thereby closing switches 26, 17 and 29. This completes the battery heating circuit through the cathode, and as soon as the cathode comes up to an electron emitting temperature the line current starts to flow in the electron tube, and the holding coil 25 will again hold the series switches 26, 17 and 29 closed. To stop the flow of current it is necessary only to throw the switch 13 to the down position, which may be done manually or electrically by well known methods.

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

1. An electron discharge device compris-

ing an evacuated container, a conductor located therein substantially in line with the main axis of said container, a cathode comprising elements grouped about said conductor in substantially the form of a revolutes, a cooperating anode arranged in the form of a revolutes about said cathode and means whereby a current, different in value from the cathode current, may be supplied to said conductor.

2. An electron discharge device comprising a sealed container, means within said container for producing an electron discharge, separate means within said container for generating a magnetic field at right angles to said discharge and means external to said container for varying said field between a minimum value at which the electron discharge is unaffected and a maximum value at which said discharge is suppressed.

3. An electrical discharge device comprising an evacuated envelope, cooperating electrodes, one of which emits electrons during operation, and a conductor, said conductor and electrodes being arranged in revolutes symmetry with respect to one another, and means whereby a current may be supplied to said conductor said current being of sufficient magnitude to generate a magnetic field capable of controlling the space current through said device by magnetostriction, said current being independent of current supplied to said electrodes.

4. An electrical discharge device comprising an evacuated envelope, an anode, a cathode comprising a plurality of elements arranged about an axis and a conductor substantially coinciding with the axis of said cathode, and means for supplying a current independent of the cathode current to said conductor whereby the electron discharge between said electrodes may be controlled by magnetostriction.

5. An electrical discharge device comprising an evacuated envelope housing, cooperating electrodes, a conductor in said envelope substantially parallel to said electrodes for generating a magnetic field at right angles to the path of an electron discharge between said electrodes, and means for energizing said conductor while deenergizing said electrodes.

6. In combination, an electron discharge device comprising a sealed container, electrodes and a conductor member mounted in the container, one of said electrodes comprising a cathode having a plurality of filamentary wires surrounding said conductor and electrically connected thereto, means for supplying current to said cathode and conductor, and means for short-circuiting said cathode and for supplying an increased current to said conductor.

7. In combination, an electron discharge device comprising an anode and a fila-

mentary cathode, means for supplying current to the cathode, means for interrupting the cathode current and simultaneously preventing electron flow between the cathode and anode, said means comprising a conductor concentrically arranged with respect to the cathode and adapted to be connected with a source of potential, the direction of current flow in the conductor being opposite to the current flow in the cathode.

In witness whereof I have hereunto set my hand this 8th day of October, 1925.

WILLIAM E. PAUL.

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