April 4, 1939. H. E. EDGERTON 2,152,639

ELECTRIC CIRCUIT

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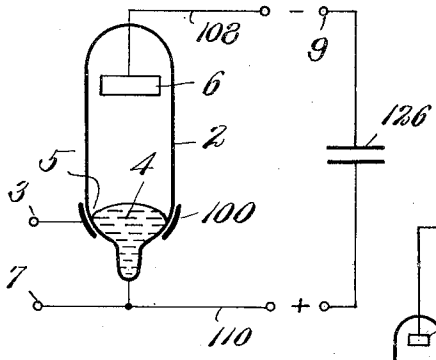


Fig. 1.

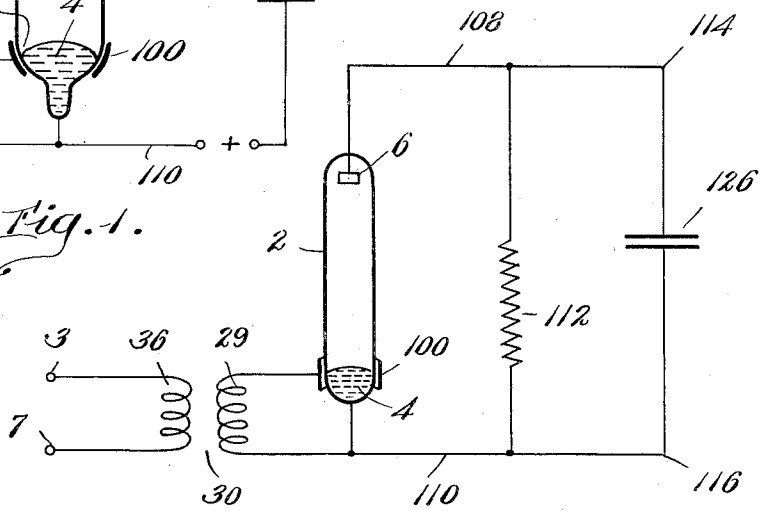


Fig. 3.

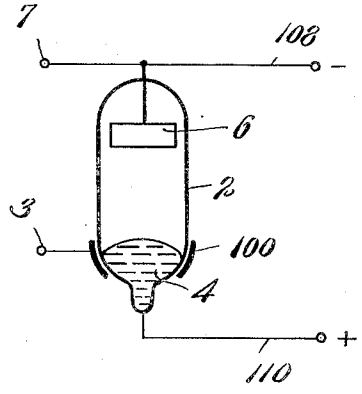


Fig. 2.

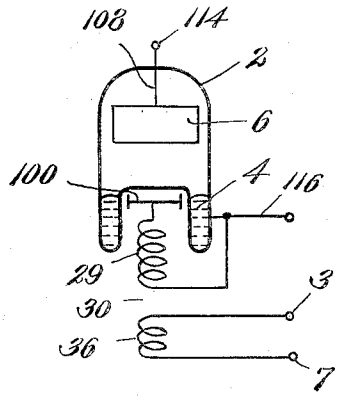


Fig. 4.

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ELECTRIC CIRCUIT

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6 Claims. (Cl. 175—354)

The present invention relates to electric circuits and more particularly to circuits for yielding direct current in circuits requiring high voltage but of low current capacity.

An object of the invention is to provide a new and improved circuit of the above-described character that shall be simple in construction, easily operable, without moving parts, and thoroughly effective and reliable in operation.

A further object of the invention is to provide a source of direct current capable of supplying circuits requiring high voltage and small currents (high impedance circuits such as X-ray tubes, cathode-ray tubes, Geiger-Muller counter tubes, etc.) without the usual rectifier tube with its filament. The circuit described in this application has a tube without a filamentary source of electrons. Those familiar with rectifier circuits will immediately recognize the unique connection of the mercury tube in the circuit.

Other and further objects will be explained hereinafter and will be particularly pointed out in the appended claims.

The invention will now be described in connection with the accompanying drawing, Figs. 1 to 4, inclusive, of which are diagrammatic views of circuits and apparatus arranged and constructed according to the preferred embodiment of the invention.

A mercury-arc tube is illustrated in all of the figures as provided with two internal electrodes in a glass envelope 2. The envelope 2 may be of the long, slender form illustrated, or it may have any other shape, such as zig-zag or helical. One of the internal electrodes is in the form of a liquid pool 4 of mercury, used for a cathode, and the other serves as the anode 6. An external, metallic eletrode 100 may serve as a starting band for facilitating the starting or operation of the tube. It is shown in Figs. 1, 2 and 3 as situated around the glass, outside of the mercury pool 4, opposite to the meniscus of the mercury. In Fig. 4, the electrode 100 is shown situated in a hollow at the lower end of the tube 2. Other types of starting bands may also be employed, such as a wire-mesh screen, a wire wound around the mercury-vapor tube 2, or a metal foil attached to the surface of the glass, though the electrode 100 may be slightly separated from the tube 2. The position of the electrode 100 is so chosen that the operation of the tube 2 is most satisfactory.

An alternating voltage is applied to the external grid 100 in the input circuit between the cathode 4 nd the grid 100 (Figs. 1, 3 and 4) or the anode and grid (Fig. 2) to start the mercury-arc tube 2. This voltage may be applied directly, as in Figs. 1 and 2, or through the medium of a transformer 30, the primary winding of which is shown at 30 and the secondary winding at 29. The alternating voltage on the external electrode is not necessarily of sinusoidal wave form and may even have a direct component. The tube 2 operates in a satisfactory manner if the wave form of the grid voltage is of any shape, as long as the instantaneous magnitude of the voltage at some time in the cycle exceeds a certain minimum value, which is about 2000 volts for the particular tube illustrated.

The operation of the circuit shown in Fig. 1 is the following. When an alternating or varying voltage is applied to the input terminals 7 and 3, it is found that a negative charge appears on the anode, raising the terminal 108 to a high negative potential. The potential will continue to rise until it is eventually limited by leakage currents, corona current, or by a back discharge through the tube 2. A condenser filter 126, if connected across the anode 6 and the cathode 4 will slow down the rate at which the potential of the anode rises. Experiment shows that the voltage across the condenser 126 rises at a nearly linear rate after the input exciting voltage has been applied. The rate of increase of voltage is directly proportional to the size of the capacity 126. As before, the ultimate limit of the potential is determined by the aforementioned factors in practical cases. Supposing these limiting factors to be absent, then the upper limit of potential depends upon the highest velocity electrons that can still arrive at the electrode against the retarding field due to the potential across the two ends of the tube.

If the cathode 4 and the anode 6 of the mercury-arc tube 2 are connected in an output circuit in any desired manner, as by means of wire conductors 108 and 110, connected with a useful load 112, direct current will be found to flow in this circuit, notwithstanding that the circuit contains no battery or other source of energy. Several thousand volts will thus be produced, at substantially constant, low current, across the output terminals 114 and 116, assuming a voltage of 10,000 volts applied to the secondary winding 29; and this without any filament from an alternating-current supply or other external aid. The output depends, of course, upon the load circuit.

The condenser 126 may be connected between the cathode and the anode in parallel to the load

112, to smooth out the alternating pulses in the output circuit. The pulses on the grid 100 need not be discontinuous, as is the case with some kinds of tubes of the character illustrated.

Further modifications will occur to persons skilled in the art, and all such are considered to fall within the spirit and scope of the invention, as defined in the appended claims.

What is claimed is:

1. An electric circuit having, in combination, a gaseous-discharge tube having an anode, a cathode and a grid, an output circuit connected between the cathode and the anode but without any source of energy therein, and means for applying a voltage between the cathode and the grid to produce a current in the output circuit between the cathode and the anode.

2. An electric circuit having, in combination, a mercury tube provided with an anode, a cathode and an external electrode, an output circuit connected between the cathode and the anode but without any source of energy therein, means for applying an alternating voltage between the cathode and the external electrode to produce a direct unidirectional voltage or current in the output circuit between the cathode and the anode, and means for smoothing out the alternating pulses in the output circuit.

3. An electric circuit having, in combination, a mercury tube provided with an anode, a cathode and an external electrode, an output circuit connected between the cathode and the anode but without any source of energy therein, means for applying an alternating voltage between the cathode and the external electrode to produce a direct current in the output circuit between the cathode and the anode, and a condenser connected between the cathode and the anode for smoothing out the alternating pulses in the output circuit.

4. An electric circuit having, in combination, a gaseous-discharge tube having two electrodes, namely, an anode and a cathode, and also a grid, an output circuit connected between the cathode and the anode but without any source of energy therein, and means for applying a voltage between one of the said two electrodes and the grid to produce a current in the output circuit between the cathode and the anode.

5. An electric circuit having, in combination, a gaseous-discharge tube having an anode, a cathode and an external electrode, an output circuit connected between the cathode and the anode but without any source of energy therein, and means for applying a voltage between the anode and the external electrode to produce a current in the output circuit between the cathode and the anode.

6. An electric circuit having, in combination, a mercury tube provided with an anode, a cathode and a third electrode, an output circuit connected between the cathode and the anode but without any source of energy therein, and means for applying an alternating voltage between the cathode and the third electrode to produce a unidirectional voltage or current in the output circuit between the cathode and the anode.

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