To all whom it may concern:

Be it known that I, Roy J. Wensley, a citizen of the United States, and a resident of Edgewood Park, in the county of Allegheny, and State of Pennsylvania, have invented a new and useful Improvement in Hot-Cathode Apparatus, of which the following is a specification.

My invention relates to electron-tube apparatus, having more particular reference to that form of apparatus wherein the electrons are produced by an incandescent cathode, and it has for its object to provide apparatus of the character designated that may be readily started into operation and which shall, furthermore, have an extremely rugged cathode structure so that it may function properly over long periods of time.

The single figure of the accompanying drawing is a diagrammatic view of a double-anode rectifier tube embodying my invention, together with the associated supply, load and starting circuits.

In the ordinary hot-cathode electron tube, the cathode is of filamentary form and is raised to incandescence by the passage of current therethrough, as from an auxiliary source. While this form of apparatus is extremely economical and efficacious, during its life, the necessity of employing a relatively fine filament, so that a small amount of heating current suffices to produce incandescence, results in rapid deterioration and destruction of the cathode, with consequent termination of the useful life of the tube.

Accordingly, I provide a cathode of relatively massive structure and I initially raise this cathode to incandescence by the passage of a relatively high-voltage discharge there-to, as from an auxiliary anode. Upon the attainment of incandescence in the main cathode, current flow takes place thereto from the main anodes, and the resultant flow of working current suffices to maintain the cathode at the desired temperature. An additional feature of my invention is that, by the use of a saturation transformer, the auxiliary anode is substantially de-energized upon the initiation of load current flow, thus conserving the starting current.

Referring to the drawing for a more detailed understanding of my invention, I show a closed tube 1 provided with main anodes 2 and 3, an auxiliary anode 4 and a cathode 5. The main anodes may be of any desired form and are shown as plates disposed on opposite sides of the cathode 5. This latter electrode is in the form of a hollow cylinder formed of refractory material, such as tungsten or carbon into which the auxiliary anode 4 projects.

Energy for the operation of the device thus described is derived through a transformer 6 comprising a core member 7 having a main primary winding 8, a main secondary winding 9 and an auxiliary secondary winding 10. The primary winding 8 is connected across suitable supply mains 11. The secondary windings 8, 9, 10 are loosely magnetically coupled to the primary winding 8, as by being wound on the opposite side of the core member 7, the winding 9 being connected to the anodes 2 and 3 and the winding 10 being connected between the auxiliary winding 6 and the cathode 5.

Magnetic lugs 12-12 may project inwardly from the core member 7 to provide a leakage path for flux around the secondary windings 9 and 10 and the core leg upon which these windings are mounted may be of restricted cross section to aid in foreing flux across between the members 12-12.

The cathode 5 is further connected to the mid point of the main secondary winding 6 through a load, as is usual in the rectifier circuit, and a resistor 14 is connected in circuit with the auxiliary secondary winding 10 to perform a current-limiting function, as will hereinafter appear.

Having thus described the arrangement of apparatus embodying my invention, the operation thereof is as follows. The bulb 1 is filled with argon, neon, helium or other suitable rare gas, at a pressure of from 3 to 18 mm. of mercury, in order to increase the conductivity thereof and in order to diminish the harmful influence of gases freed from the electrodes and from the container walls. Upon supplying current to the transformer 7 through the mains 11, rectification from the main anodes 2 and 3 cannot take place because of the absence of electrons within the tube 1. The secondary winding 10 embodies a relatively large number of turns, however, so that a relatively high voltage is developed between the auxiliary anode 4 and the main cathode 5. The application of this voltage, together with the presence of
the rarified atmosphere within the tube 1, permits the initiation of alternating-current flow between the electrodes 4 and 5, rapidly raising the latter to incandescence. The attainment of incandescence initiates a profuse electron emission from the cathode 5, and certain of these electrons impinge upon the anodes 2 and 3, causing current flow from the latter, this current flow being rectified to pass through the load 13.

The initiation of load-current flow decreases the electromotive force of the auxiliary winding 10 and thus, together with the current-limiting function of the member 14, largely suppresses the auxiliary exciting current.

The flow of the working current maintains the cathode 5 at incandescence so that operation may be continued as long as is desired, and the device is automatically restarted in case of temporary interruption.

The cathode 5 is particularly large and massive in structure, as contrasted with the usual incandescent cathode, and thus a long cathode life is insured.

While I have particularly described operation with a gas-filled tube, the same inventive concept is susceptible of application with highly-evacuated tubes wherein the emission is of the pure-electron type, and various other modifications will occur to those skilled in the art.

I claim as my invention:

1. In an electron-tube device, the combination with a cathode, of a main anode, a load circuit joining said electrodes through a source of alternating electromotive force, an auxiliary anode, means for producing a discharge from said auxiliary anode to said cathode, whereby the cathode is raised to incandescence and the flow of current through said load circuit is initiated, and means whereby said flow of load current reduces the amount of said starting discharge.

2. The combination with an electron-tube device embodying a main anode, a main cathode and an auxiliary anode, of a supply transformer embodying a primary winding, a main secondary winding, an auxiliary secondary winding, and connections from said main secondary winding to the main anode and to the cathode and from the auxiliary secondary winding to the auxiliary winding and the cathode, said auxiliary winding being mounted on a core member of restricted cross-section, whereby saturation therein is produced upon the flow of current in the main secondary winding.

3. In an electron-tube system, the combination with an electron-tube embodying a cylindrical cathode, a main anode mounted adjacent thereto and an auxiliary anode projecting thereinto, said tube having a filling of rarified gas, of a transformer embodying a closed-core member having a primary winding and main and auxiliary secondary windings loosely coupled to said main winding, the core member of said transformer providing a leakage path in shunt relation to the portion of the core member upon which said secondary windings are mounted, and connections from said main secondary winding to said main anode and to the cathode and from the auxiliary secondary winding to the auxiliary anode and the cathode, the electromotive forces produced in said windings and the spacing of the electrodes being such that, upon the energization of the transformer, a discharge is initiated from the auxiliary anode to the cathode, heating the latter, whereupon current flow takes place from the main anode to the cathode and the flux conditions within the transformer are altered so as to reduce the electromotive force produced in said auxiliary secondary winding.

4. In an electron-tube device, the combination within a cathode, of a main anode, a load circuit joining said electrodes through a source of alternating electromotive force, an auxiliary anode, means for producing a discharge from said auxiliary anode to said cathode, whereby the cathode is raised to incandescence and the flow of current through said load circuit is initiated, and means whereby said flow of load current reduces the amount of said starting discharge, and current-limiting means in series with said auxiliary anode for selectively limiting the current therein when said discharge is reduced.

In testimony whereof, I have hereunto subscribed my name this 31st day of July, 1919.

ROY J. WENSLEY.