Aug. 9, 1932. P. H. BRACE 1,871,357

PHOTO-ELECTRIC TUBE

Original Filed June 30, 1921

Fig. 1.

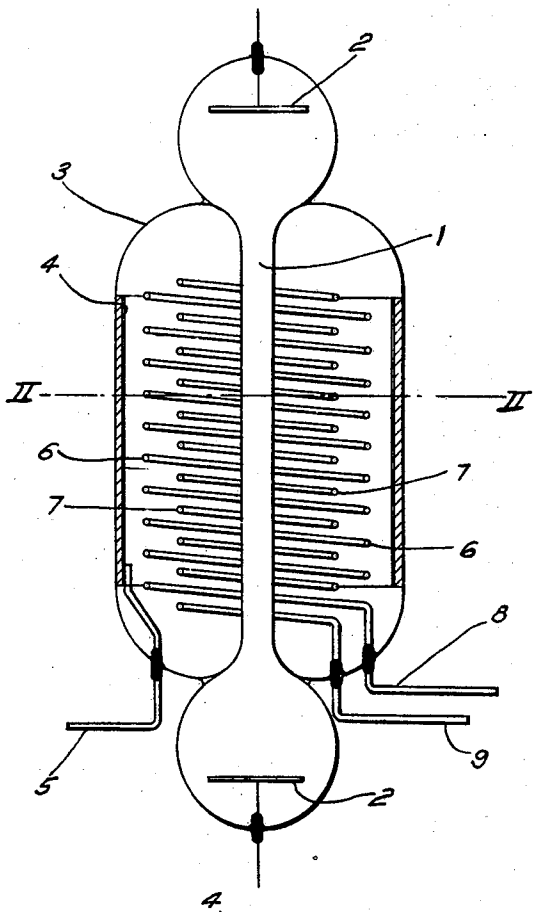
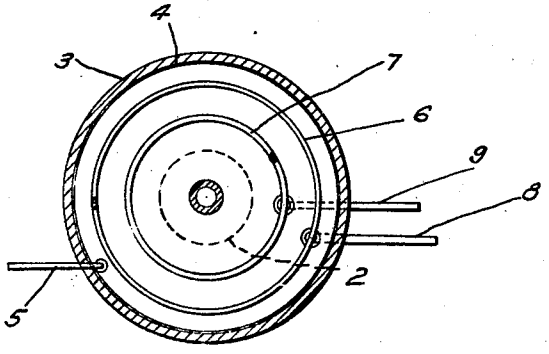


Fig. 2.



WITNESSES:

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UNITED STATES PATENT OFFICE

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PHOTO-ELECTRIC TUBE

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My invention relates to electron tubes or audions and particularly to those electron tubes in which it is not necessary to heat the cathode in order to cause electrons to be emitted therefrom.

One object of my invention is to provide an electron tube which, because of its special construction and arrangement of parts, shall be very sensitive in its operation and which shall be particularly adapted for use as a sensitive detector having a minimum distorting effect.

Another object of my invention is to obviate the disadvantages of the ordinary thermionic tube by employing a cold cathode and utilizing what has come to be known in the art as the photo-electric effect or the property of certain bodies of giving off electrons when exposed to light.

A further object of my invention is to provide an electron-discharge device that shall have a unipotential cathode; that is, a cathode all parts of which are always maintained at the same potential.

At present, electron tubes commonly utilized, as a cathode, a lamp type filament heated by the flow of current through it from some external source. The presence of the highly heated cathode precludes the practical use of such a relative arrangement of the tube electrodes as is possible with a cold cathode. It also prevents the location of the control electrode in as close proximity to the cathode as is desirable.

Furthermore, because of the resistance of the filament, there will be a difference of potential between the two ends thereof, or, in other words, a potential gradient will exist over the remainder of the filament with respect to one end. Hence, it is impossible for all parts of the filament to be at the same potential with respect to the control electrode or "grid," a condition which reduces the capacity and sensitiveness and, at least for certain uses, impairs the efficiency of the tube.

In my electron tube I utilize the photo-electric effect to produce the emission of electrons from the cathode and by this means, together with the novel form of cathode and the relative arrangement of the electrodes hereinafter described in detail, I overcome the above mentioned difficulties. It is well known that certain substances emit electrons when exposed to light. Examples of such substances are the alkali metals, for instance, potassium. In order to make use of the photo-electric effect in an electron tube, I employ as the cathode an alkali metal such as potassium and I so arrange a source of light that its rays shall fall upon the photo-electrically active surface of the cathode. A source of light of short wave-length is preferable.

The usual anode and control electrode are provided. In the preferred embodiment of my invention, the cathode is made cylindrical in form, and the control electrode, the anode and the light source are all disposed within the cylindrical cathode so that the cathode surrounds all of the other elements of the tube.

In the drawings, Figure 1 is a longitudinal sectional view of my electron tube.

Fig. 2 is a transverse sectional view taken on the line II—II of Fig. 1.

In Fig. 1, is shown a discharge tube 1, which furnishes light by reason of the luminescence of a column of gas or metallic vapor. Hydrogen and mercury are suitable for my purpose. Electrodes 2, 2 are provided for connection with any suitable source of energy.

An envelope 3 surrounds the discharge tube 1 and has its interior cylindrical surface coated with some photo-electrically active substance 4, for example, potassium. The photo-electrically sensitive coat 4 constitutes the cathode. The envelope 3 may be exhausted or may be filled with a suitable gas at certain low pressures, for example, helium, at a pressure of a few millimeters of mercury. Making electrical connection to the cathode 4, is a terminal 5.

A helix or other reticulated cylinder 6 of metallic wire or gauze constitutes the control electrode or grid, which is completely surrounded by the cathode 4. A similar helix or other reticulated cylinder 7 of metallic wire or gauze, lying within the control electrode

6, constitutes the anode of the tube. Terminals 8 and 9 are provided for forming electrical connection with the grid 6 and the anode 7, respectively.

The operation of my electron tube is as follows. When the discharge tube 1 is energized, the rays of light therefrom pass through the meshes of the cylinders 7 and 6 and strike the surface 4 of the cylindrical cathode, thereby causing it to emit electrons.

The electrons travel in the direction of the anode 7, and the number of electrons reaching the anode may be controlled exactly as are the electrons from the heated filament in the ordinary audion tube, that is, by the variation of the relative potentials of the anode 7, grid 6 and cathode 4.

Since all portions of the surface of the cathode 4 are at the same potential, there is no potential gradient over it with respect to the control electrode and, therefore, the electron emission from the cathode will be a maximum for any given set of relative potentials between the cathode, control electrode and anode.

Because the light comes from a distributed source, there will be no shadows cast upon the surface of the cathode by the anode and control electrode, consequently, the emission of electrons over the entire area of the cathode will be uniform.

It will be seen that, by reason of the novel configuration of the cathode and the arrangement of the grid and anode so that they are both surrounded by the cathode, a much larger proportion of the total electrons emitted by the cathode will reach the anode than in a tube of the ordinary filament type. This construction, combined with the unipotential cathode and the positioning of the control electrode in close proximity to the cathode, enables me to produce an electron tube that is more sensitive than those which have been made heretofore.

Though I have shown a preferred construction illustrating the principles of my invention, it will be understood that various modifications will suggest themselves to those skilled in the art. I desire, therefore, that my invention shall be limited solely by the prior art and the scope of the appended claim.

By the term "line-source" of light, as used in certain of the claims, is meant simply a source which possesses considerable length relative to its breadth.

I claim as my invention:

An electron-tube device comprising a discharge lamp as a source of light, an apertured tubular anode surrounding said lamp and spaced therefrom, an apertured tubular control electrode surrounding said anode and lamp and spaced therefrom, and a tubular cathode, said cathode constituting the outermost electrode and having its inner surface made of a material which emits electrons in response to light rays the spacing of said anode and said control electrode from said lamp being sufficient to prevent shadows being cast thereby on said cathode when said lamp is in operation.

In testimony whereof, I have hereunto subscribed my name this 23rd day of June, 1921.

PORTER H. BRACE.