

Jan. 5, 1943.

O. T. McILVAINE

2,307,697

ELECTRONIC TUBE

Original Filed July 9, 1934

Fig. 1.

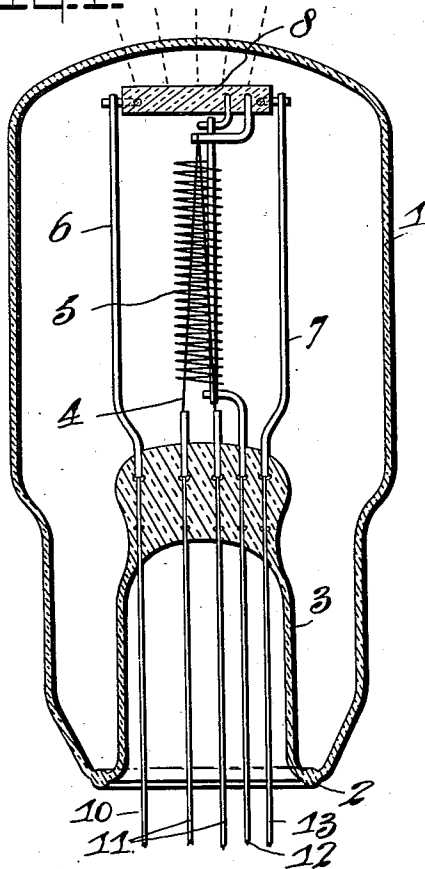


Fig. 3.

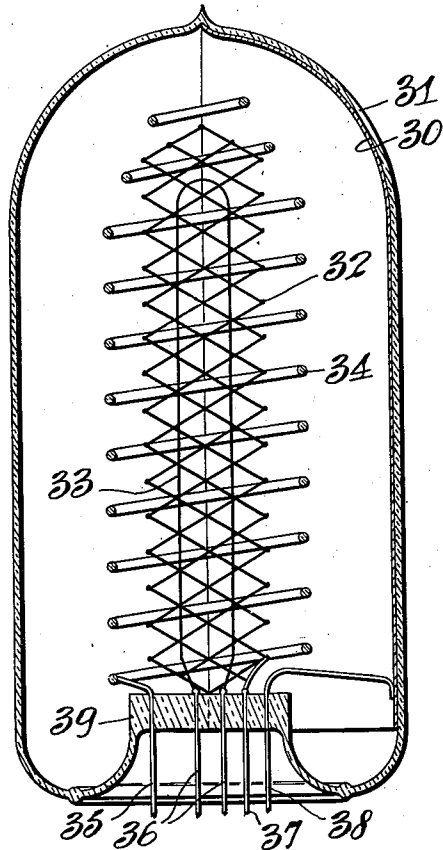


Fig. 2.

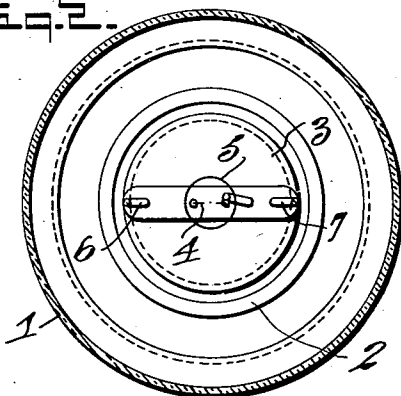
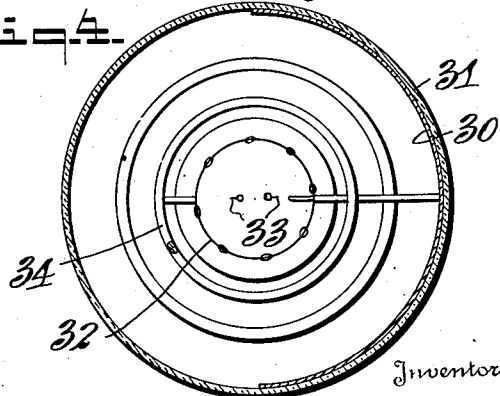


Fig. 4.



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UNITED STATES PATENT OFFICE

2,307,697

ELECTRONIC TUBE

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Original application July 9, 1934, Serial No. 734,352. Divided and this application December 5, 1940, Serial No. 368,711

5 Claims. (Cl. 250—165)

This application is a division of my application on Electronic device, filed July 9, 1934, Serial No. 734,352 which was a continuation-in-part of my application, Ser. No. 209,281, filed July 29, 1927, for Electronic tubes, which application matured into Patent No. 1,965,849, on July 10, 1934.

This invention relates to electronic devices, such as, electronic tubes for use in connection with the transmission and reception of electromagnetic impulses or radio signals.

Attempts have been made heretofore to combine a photo-electric tube with a thermionic tube, with the photo-cathode connected with the grid of the thermionic tube in one envelope, but the action was the same as when two separate envelopes were employed, resulting only in a more complex and expensive structure.

The primary object of this invention is to combine a photo-electric tube with a thermionic tube so that the electronic streams are intermingled in controlling the thermionic emission directly by the flow of photo-emission from the photo-cathode, the two currents being reactive in the space between the various elements of the tube, the electronic streams themselves being employed for controlling the action.

The present invention has for further objects thereof the provision of an electronic tube of simple and inexpensive construction which will operate successfully for an indefinitely long period of time; the provision of a simple and inexpensive type of tube which can be used with either direct or alternating current or other sources of light and heat; the provision of a power tube with a light-sensitive electrode for controlling, by the flow of photo-emission therefrom, the electron emission of the thermionic cathode of the tube by changing the potential of either the anode or grid of the tube; and the provision of a light-sensitive power tube, having associated therewith, a light source which may be modulated or controlled by or in accordance with incoming radio signals or electric impulses.

With these and other objects in view, the invention consists in the novel construction, arrangement and combination of parts, hereinafter illustrated and described in some of its embodiments in the accompanying drawing, and particularly pointed out in the appended claims.

In the drawing, certain illustrated embodiments of the invention are shown, in which:

Fig. 1 is a vertical sectional view of a tube illustrative of one form of the invention;

Fig. 2 is a transverse sectional view thereof;

Fig. 3 is a vertical sectional view of another or modified form of tube; and

Fig. 4 is a transverse sectional view thereof.

In the form of the invention shown in Fig. 1, the tube comprises a sealed glass container in the form of an envelope having a side wall 1 fused at its lower end 2 to a tubular stem or press 3 which carries the various elements of the tube. The tube may be highly evacuated or it may be filled with one of the inert gases such as, neon. The elements of the tube shown in Fig. 1, include a hot cathode in the form of a wire filament 4, a light-sensitized grid element 5, an anode element 6, an anode 7 and a support 8 for the foregoing elements.

The anode 7 can also be used to collect the electrons emitted from the hot cathode 4, it being controlled in accordance with the variation in light impinging on the sensitized grid element 5 supplied from a light source (not shown) fluctuating in accordance with incoming signals transmitted by a fluctuating current. Both the anode element 6 and the anode 7 may be used for the same purpose or either one of them may be operated as a photo-anode and the other as a thermionic anode by the selection and use of proper electrical connections (not shown) as will be understood by one familiar with the art to which this invention relates.

By properly choosing the circuit constants for these two circuits, many novel results can be obtained. In this particular device, the grid itself is photo-sensitized and it varies the hot cathode emission from the filament 4 to the anode element 6 or the anode 7. Lead wires 10, 11, 12 and 13, traversing the press 3 of the tube, are connected to the anode element 6, each of the terminals of the hot cathode 4, the grid element 5 and the anode 7 respectively.

The sensitizing of the grid 5 in Fig. 1, controlling the emission of electrons under the influence of light acting thereon, renders far more effective the electron stream from the hot cathode to the anode of the thermionic tube, than if the photo-emission were used merely to change the potential on the grid. Each electron emitted by the grid under the influence of light has a much better control than if it were used merely to change the potential on the grid.

In Fig. 3 there is a modified form of tube in which a photo-cathode 30 is located on the inner surface of the outer wall 31 of the tube and it consists of a material, many of which are known, which emits electrons when exposed to light. An anode 32 made of a net-work of wires which al-

lows the passage of light from a heated filament 33 is arranged to absorb and carry away the electrons emitted by the filament 33. The flow of electrons from the cathode or filament 33 to the anode 32 may be controlled by a grid element 34.

The potential of the grid 34 may be controlled by the electrons emitted from the photo-cathode 30 which in this case is on the inside of the tube, and these electrons are drawn to the grid 34, which in this respect is the anode for the photo-cathode 30. This current flow, by changing the potential on the grid 34, thereby controls the electron stream from the hot cathode 33 to the anode 32.

In this form, the grid 32 forms the anode for the photo-cathode 30, while the grid 34 constitutes the anode for the hot cathode 33. Thus the two electron streams are intermingled in the space between the grids 32 and 34. This has the effect of a much greater grid control on a thermionic electron flow than if the voltage of grid 32 were varied from an outside potential. In this way the electron streams themselves are employed for the controlling action.

By this method, a very feeble photo-current may be used to control a very large thermionic emission from the hot filament. For some purposes, such as where a certain bias voltage is not required on the grid 34, a black emitter can be used which gives no light and has no substantial effect on the photo-cathode. A cathode of this type would be a caesiased tungsten cathode or some similar cathode as described in the tubes of application, Serial No. 209,281, previously referred to, now Patent No. 1,965,849.

Another manner of using the tube shown in Fig. 3 would be that of using the wire network 32 as the grid and using the coil 34 as the anode, in which case electrons are supplied to the anode 34 by the filament 33 which is preferably heated to incandescence for such purpose and also for the purpose of providing a light source for the excitation of the photo-cathode 30. With this arrangement, the fixed bias on the grid 32 may be varied through the control of the electron emission of the photo-cathode 30 by changing the brilliancy of the filament 33. Any fluctuating light incident upon the photo-cathode would then operate around this point as an operation point.

Light may be admitted to the surface of the photo-cathode through the photo-cathode itself which consists of a light-sensitized transparent film of metal on the inside wall of the tube, or if an opaque coating is used, light can be admitted through either end of the tube by omitting the coating at these points, or as is done in the present case, light can be admitted through one side of the tube by omitting the coating there as is done in the tube shown in Fig. 3. Suitable leads 35, 36, 37 and 38 traverse a press 39 sealed in the tube and they are connected respectively to the anode or grid 34 as the case may be, the heater filament 33, the grid or anode 32 as the case may be and the photo-cathode 30.

Both forms of the invention disclosed herein include two different sources for the emission of electrons, as for example, the hot and cold cathodes shown, the latter of which is controlled by a source of light, so that the operation of the tube can be varied and controlled by means of a light source having no electrical connection with the tube elements. The use of a light source in this manner is of tremendous advantage in some types of radio work and by the proposed use of the tubes shown herein, it is possible to greatly reduce the

number of tubes formerly thought necessary to produce the desired degree of amplification of radio or wireless signals without objectionable distortion.

The tubes may be either highly evacuated or they may be filled with one or more inert gases commonly used for such purpose.

While the light sources described in connection with the tubes shown in Figs. 1 and 3, are not specifically illustrated in the drawing, it is intended that any suitable source of radiant energy, visible or invisible, which fluctuates under the influence of a fluctuating electrical current, might be used in connection with the various tubes shown.

Photo-cathodes can be selectively sensitized to respond to different frequencies of light by utilizing the selective photo-electric effect which is a characteristic of the alkali and alkaline earth metals and also by having the light strike the photo-cathode with an angle of incidence of about 60°, in which case, the different metals show a strong maximum of photo-electric sensibility over a very short part of the spectrum, which differs with the different metals and which maximum effect may be varied through selection of the proper metals so as to occur at different predetermined portions of the spectrum.

By forming the cathode surface from such metals as, caesium, rubidium, potassium and sodium, and alloys of the same, photo-cathodes can be made having a maximum response to obliquely incident light rays for various preselected portions of the visible spectrum. This phase of the invention might be utilized in color television work and the transmission of images in their natural colors.

One of the more important features of this invention is that of employing a relatively small photo-current of primary emission to control a relatively large thermionic current directly in proportion to the photo-current, thereby giving a high amplification of an original feeble impulse, and many modifications of the general principles of tube construction disclosed herein, may be made without departing from the invention; as for example, by varying the arrangement and number of the different elements of the tubes and by the use of various kinds of emitters and other changes as will occur to one skilled in the art.

Furthermore, it is to be understood that the particular forms of electronic devices shown and described, and the particular procedure set forth, are presented for purposes of explanation, and that various modifications of said apparatus and procedure can be made without departure from this invention as described in the appended claims.

I claim:

1. An electronic tube comprising an envelope having assembled therein an electronic cathode and an anode spaced therefrom, a photo-cathode and a photo-anode therefor mounted in spaced relation in said envelope, one of said photo elements being intermediate the first-mentioned electronic elements, and one of said electronic elements being in the electron path formed by the photo elements.

2. An electronic tube comprising an envelope having assembled therein an electronic cathode and an anode spaced therefrom, a photo-cathode and a photo-anode therefor mounted in spaced relation in said envelope, one of said photo elements being intermediate the first-mentioned

electronic elements, and one of said electronic elements being in the electronic path from the photo-cathode to the photo-anode forming intersecting electron paths.

3. An electronic tube comprising an envelope 5 having assembled therein an electronic cathode and an anode spaced therefrom, a photo-cathode and a photo-anode therefor mounted in spaced relation in said envelope, one of said photo elements being intermediate the first-mentioned 10 electronic elements, and the first-mentioned anode being in the electron path of the photo elements.

4. An electronic tube comprising an envelope having assembled in a chamber therein an elec- 15 tronic cathode and anode spaced therefrom and

a control element, a photo-cathode and a photo-anode therefor mounted in spaced relation in said chamber of the envelope, one of said photo elements being formed on the control element.

5. An electronic tube comprising an envelope having assembled in a chamber therein an electronic cathode and anode spaced therefrom and a control element, a photo-cathode and a photo-anode therefor mounted in spaced relation in said chamber of the envelope, one of said photo 10 elements being formed on the control element intermediate the first-mentioned electronic elements, and one of the first-mentioned electronic elements being in the electron path of the photo 15 elements forming intersecting electron paths.

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