Feb. 22, 1938. R. A. BRADEN 2,108,880

ELECTRIC DISCHARGE TUBE

Filed April 27, 1934

Fig. 1.

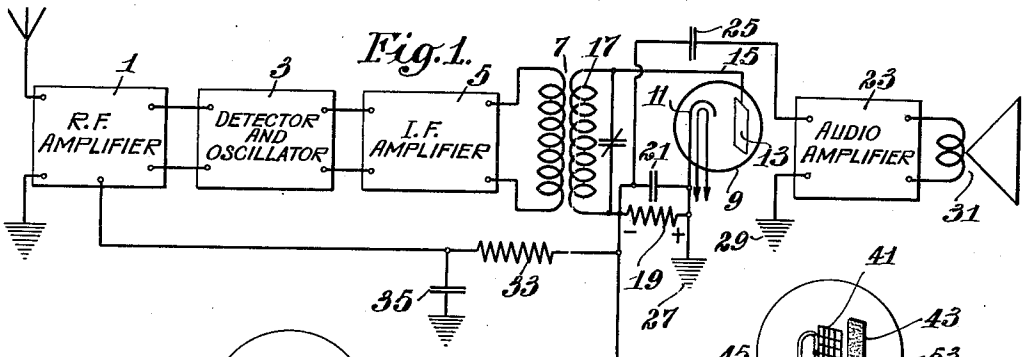
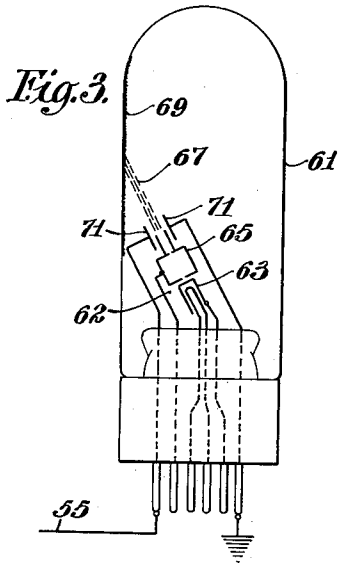


Fig. 3.



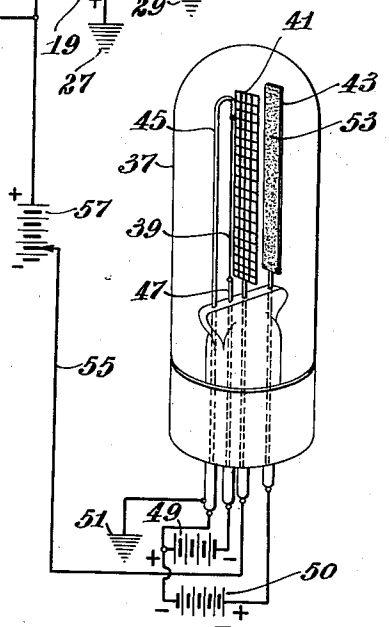


Fig. 4.

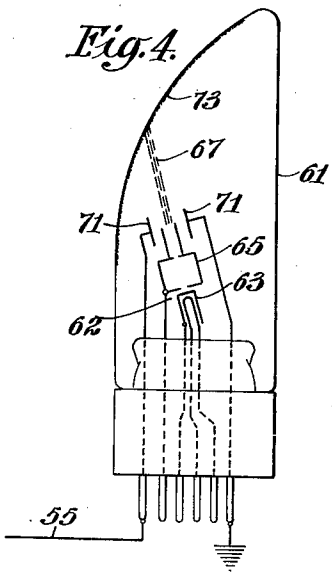
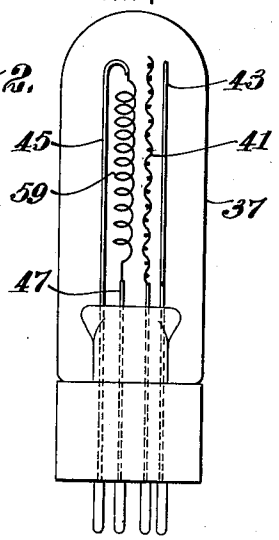


Fig. 2.



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Patented Feb. 22, 1938

2,108,880

UNITED STATES PATENT OFFICE

2,108,880

ELECTRIC DISCHARGE TUBE

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Application April 27, 1934, Serial No. 722,746

6 Claims. (Cl. 250—40)

My invention relates to electric discharge tubes of the cathode-ray type and, particularly, to cathode-ray tuning indicators for radio receivers.

An object of my invention is to provide a tube of the above-mentioned type in which a column of light is produced having a height which varies in accordance with a control voltage.

A further object of my invention is to provide a cathode-ray tube which may be operated at comparatively low voltages.

A further object of my invention is to provide a cathode-ray tube in which comparatively small changes in potential applied to a control electrode or deflecting device will have a large effect upon the electron stream or cathode-ray.

A still further object of my invention is to provide improved means for indicating when a radio receiver is tuned exactly to an incoming signal.

In one embodiment of my invention, I utilize, in combination with a radio receiver having automatic volume control, a vacuum tube having a long, straight filament for supplying a narrow stream or band of electrons. These electrons are directed against a plate or screen coated with fluorescent material whereby a column of light is produced. The height of this column of light is determined by the percentage of the filament length which is permitted to supply electrons which reach the fluorescent screen.

In another embodiment of my invention, an evacuated envelope is provided with an electron gun which is located at an acute angle to a fluorescent screen whereby a small deflection of the cathode-beam produces a large change in the position of the resulting light spot on the screen.

Other objects, features and advantages of my invention will appear from the following description taken in connection with the accompanying drawing in which:

Figure 1 is a view of a radio receiver which includes one embodiment of my invention; and

Figs. 2, 3, and 4 are views showing other embodiments of my improved cathode-ray tube.

Referring to Fig. 1, there is shown a radio receiver of the superheterodyne type which includes a radio frequency amplifier 1, a first detector and oscillator 3 for converting the incoming signal to an intermediate frequency signal, and an intermediate frequency amplifier 5. The output circuit of the intermediate frequency amplifier 5 is connected through a tuned intermediate frequency transformer 7 to a diode 9 which functions both as a second detector and as an automatic volume control tube.

The diode comprises an indirectly heated cathode 11, which is connected to ground as indicated at 27, and an anode 13. The anode 13 is connected through a conductor 15 to one end of the secondary 17 of the transformer 7, while the cathode 11 is connected through a resistor 19 to the other end of the secondary 17. In order that the output of the transformer 7 may be impressed across the anode 13 and the cathode 11 through a low impedance circuit, the resistor 19 is shunted by an intermediate frequency by-pass condenser 21.

When a modulated intermediate frequency carrier is impressed upon the diode 9, the audio frequency signal will appear across the resistor 19. This signal is impressed upon the input circuit of an audio frequency amplifier 23 by means of a coupling condenser 25 and a connection through ground indicated by the conventional symbols 27 and 29. The output of the amplifier 23 may be supplied to a loudspeaker 31.

An automatic volume control circuit is provided in order to overcome the effects of fading of an incoming signal. This circuit includes a connection from the anode end or negative end of the resistor 19 through a filter resistor 33 to suitable points in the circuit of the radio frequency amplifier 1, such as the control grids of the radio frequency amplifier tubes which are made more negative as the strength of an incoming signal increases. A filter condenser 35 is connected between one end of the filter resistor 33 and ground for filtering out audio frequency signals whereby the volume control potential applied to the radio frequency amplifier 1 varies only in accordance with slow variations in signal strength due to fading.

Because of the automatic volume control circuit, it is difficult to tune the receiver exactly to incoming signals merely by listening to the loudspeaker output. It is especially desirable, therefore, to provide the receiver with visual indicating means to indicate when the receiver is tuned exactly to the desired signal.

I have provided such indicating means in the form of a vacuum tube 37 comprising a straight elongated cathode 39, a control grid 41 and an anode 43. The anode 43 is preferably in the form of a flat plate which is rectangular in shape. The grid 41 may consist of a flat rectangular sheet of mesh material. In order to prevent electrons from going around the grid 41, it is preferably made wider than the anode 43. If desired, the grid may be made in the form of a mesh cylinder surrounding the filament. The cathode 39 is

in the form of a directly heated filament which is supported at each end by suitable supporting members 45 and 47.

The spacing between the tube electrodes 39, 41, and 43 should be small in comparison with their length to reduce "fringing" of the electrons at their cut-off point. The reason for this is that there are a certain number of electrons which do not leave the filament at right angles thereto. Therefore, there will be a small fringe of light at the end of the luminous column on the screen 53, this fringe being reduced as the spacing between tube elements is reduced.

The cathode may be heated from any suitable source of direct current such as a battery 49. In the particular embodiment illustrated, the positive terminal of the battery 49 is connected to the upper end of the cathode 39, this end of the cathode being connected to ground as indicated by the conventional symbol 51. The anode 43 is supplied with a positive potential from any suitable source of direct current, such as the unit which supplies voltage for the plates of the radio receiver tubes or a battery 50. It will be understood that the negative terminal of this direct-current supply unit is connected to ground whereby the potential difference between the upper end of the cathode 39 and the anode 43 is equal to the voltage supplied by the said unit. It will be apparent that the potential difference between the lower end of the cathode 39 and the anode 43 is equal to the voltage of the said plate supply unit plus the potential drop along the cathode.

The side of the anode 43 which faces the cathode 39 is coated with a fluorescent material 53 so that the face of the anode glows to form a column of light when it is bombarded by electrons from the cathode 39.

The control grid 41 is connected through a conductor 55, and, if desired, a biasing battery 57 to the anode end of the resistor 19 whereby the grid 41 becomes more negative in response to the reception of an incoming signal. When the receiver is not tuned to an incoming signal, the grid 41 is at such a potential with respect to the upper end of the cathode 39 that the electrons emitted from the entire length of the cathode strike the fluorescent coating 53 to produce a long column of light. As the receiver is tuned to an incoming signal, the grid 41 becomes more negative, and by proper adjustment of the voltages in the circuit, the negative grid 41 will prevent the electrons emitted from the upper end of the cathode 39 from striking the fluorescent coating 53. Thus the column of light on the anode 43 becomes shorter, and the greater the negative potential applied to the control grid 41, the shorter the column of light becomes until, when the receiver is tuned exactly to the desired signal, the grid is negative the maximum amount and the column of light has been shortened to its minimum length. From the above description, it will be understood that in tuning the receiver, the indicator tube 37 is watched and the tuning adjusted until the column of light reaches its minimum length.

In order that a varying potential on the control grid 41 shall have a control effect of the desired magnitude, the potential drop along the cathode 39 should be fairly large. For example, in the case illustrated in Fig. 1, ten volts may be applied across the filament.

A still greater control may be obtained by employing the construction shown in Fig. 2 in which figure parts similar to those in Fig. 1 are indicated by the same reference numerals. This tuning indicator is the same as the tube 37 shown in Fig. 1 except that the straight filament has been replaced by a directly heated filament 59 which has been coiled to increase the length of filament for a given cathode length. By utilizing this type of cathode, a 110 direct-current voltage supply, for example, may be connected directly across the filament 59.

If desired, instead of coiling the filament 59 uniformly from one end to the other, one end of the coiled filament may be "stretched out" as indicated in the drawing. This causes most of the potential drop to be along the upper section of the cathode so that if the tube is used in the circuit shown in Fig. 1, the light column will not change greatly until the receiver is tuned almost exactly to the desired signal, at which time the grid 41 will become negative enough to stop the current flow between the upper end of the cathode and the plate, and thereby suddenly shorten the column of light.

An important advantage of my above-described tuning indicator tube is that it may be operated at lower voltages than required for cathode-ray tubes of the conventional type. This permits the use of the regular radio receiver voltage supply and the necessity for a special high voltage supply is avoided.

Another embodiment of my invention is illustrated in Fig. 3. In this embodiment, an evacuated envelope 61 has an electron gun 62 located therein, this gun comprising an indirectly heated cathode 63 and an anode 65 having an opening therein through which the electrons pass to form the cathode-ray or beam indicated at 67. As such structure is well known in the art, a detailed description is not believed necessary.

A fluorescent screen 69 is provided which may be in the form of a coating of fluorescent material on the interior of the glass envelope 61.

In accordance with my invention, the axis of the electron gun 62 is positioned at an acute angle with respect to the fluorescent screen 69 as indicated in the drawing.

Any suitable means may be provided for deflecting the cathode-ray, such means being illustrated in the drawing as a pair of electrostatic deflecting plates 71. Since the undeflected cathode-ray 67 strikes the fluorescent screen 69 at a sharp angle, a slight deflection of the cathode-ray will produce a comparatively large change in the position of the luminous spot on the fluorescent screen. Therefore, a rather small voltage change produced on the deflecting plates 71 by the reception of an incoming signal will produce a very decided change in the position of the luminous spot on the screen to indicate that the receiver has been tuned exactly to the incoming signal.

The cathode-ray tube illustrated in Fig. 4 is the same as that shown in Fig. 3 except for the difference in shape of the fluorescent screen, like parts in the two figures being indicated by the same reference numerals. In Fig. 4, a fluorescent screen 73 is illustrated as having a curvature such that a voltage applied to the deflecting plates 71 in accordance with a square law causes a linear deflection of the luminous spot on the fluorescent screen. It will be understood that the fluorescent screen may be given other shapes in order to cause the shift or deflection of the luminous spot thereon to vary in a desired relation with respect to the voltage applied to the de-

flecting plates. Either the envelope 61 may be shaped to give the screen 73 the proper curvature, or the screen 73 may be supported in the envelope 61 upon a separate supporting surface.

From the foregoing description it will be apparent that various other modifications may be made in my invention without departing from the spirit and scope thereof and, I desire, therefore, that only such limitations shall be placed thereon as are necessitated by the prior art and set forth in the appended claims.

I claim as my invention:

1. An electric discharge tube comprising an elongated cathode adapted to emit electrons, an anode, a fluorescent material coating upon said anode and in the direct path of the emitted electrons, means for directing said electrons against said screen, and means for selectively preventing a portion of said cathode from supplying electrons which reach said screen.

2. An electric discharge tube including elongated fluorescent screen, an elongated means for developing a stream of electrons and directing said stream upon said screen, said stream being substantially rectangular in cross-section whereby a column of light is produced on said screen, and means for producing a variable voltage gradient longitudinally of said electron developing means and said screen for varying the length of said column of light.

3. An electric discharge tube including a fluorescent screen, means including an elongated cathode for impressing a stream of electrons upon said screen, said stream having a shape in cross-section such that a column of light is produced on said screen, and means for varying the voltage gradient over the length of said cathode and between the cathode and the screen for varying the length of said column.

4. In an electric discharge tube, an elongated cathode adapted to emit electrons, an anode, a fluorescent screen material coated upon said anode and positioned to receive said electrons, and control electrode means intermediate the cathode and the fluorescent coated anode for controlling the length of said cathode which is effective to supply electrons which reach said screen.

5. In a radio receiver, an electric discharge tube comprising an elongated cathode consisting of a directly heated filament, means for producing a flow of current through said filament which causes one end of the cathode to be at a different potential than the other end, a control electrode, an anode, a fluorescent material coating upon said anode and positioned to receive directly the electrons emitted from said cathode whereby a luminous column is formed thereon, and means for applying a voltage to said control grid in response to tuning the receiver to an incoming signal which voltage has a value such as to change the length of said luminous column.

6. An electron discharge tube claimed in claim 4 wherein the control electrode positioned intermediate the cathode and the fluorescent coated anode is of larger dimensions than either the anode or cathode to prevent electron flow between the cathode and anode in a path other than through the control electrode.

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