April 12, 1938. H. C. THOMPSON 2,113,669

TUNING INDICATOR TUBE

Filed Sept. 26, 1936

Fig. 1

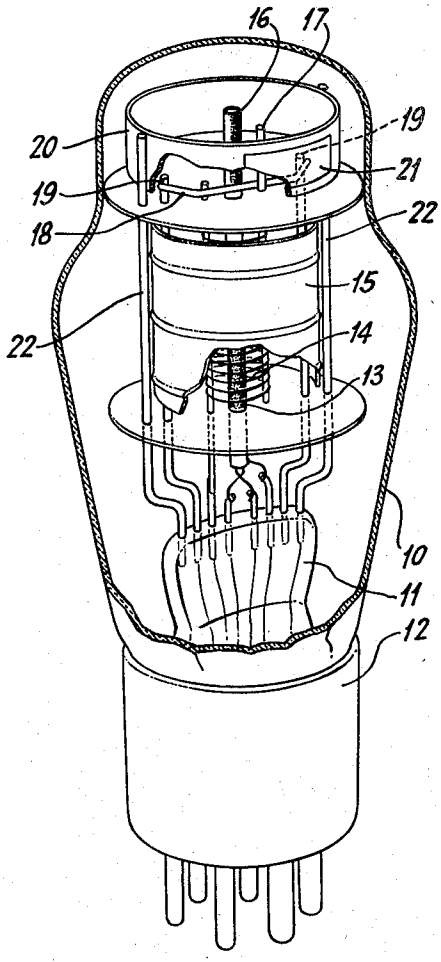


Fig. 2a

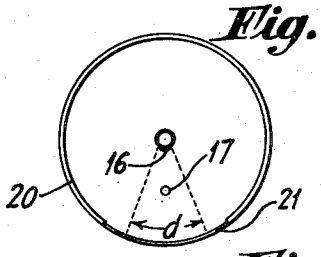


Fig. 2b

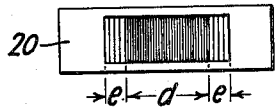


Fig. 3a

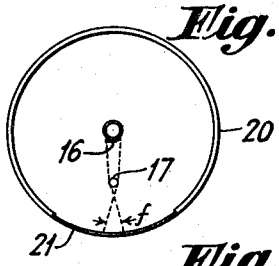


Fig. 3b

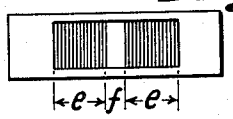
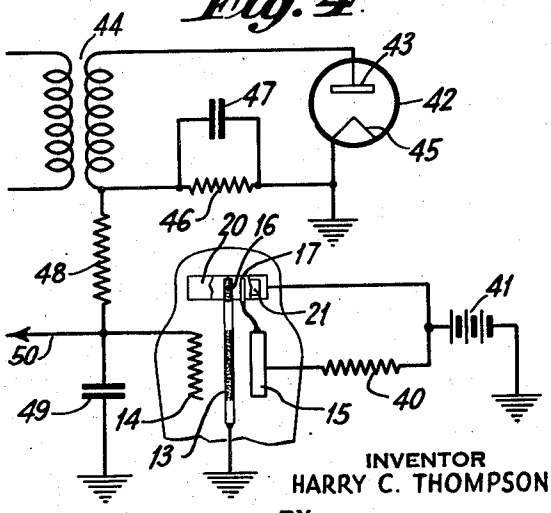


Fig. 4



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Patented Apr. 12, 1938 2,113,669

UNITED STATES PATENT OFFICE

2,113,669

TUNING INDICATOR TUBE

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Application September 26, 1936, Serial No. 102,709

4 Claims. (Cl. 250—27.5)

My invention relates to electron discharge devices, more particularly to such devices useful as visual indicators of voltage and having an electrode which is rendered incandescent, and has the appearance of a pattern of light which may be of constant height and varying width and which changes in response to the change in the magnitude of the applied voltage, a device of this character being particularly useful as a tuning indicator in radio receiving sets.

It is an object of my invention to provide an improved electron discharge device of the kind described, which is particularly suitable for use as a visual tuning indicator in a radio receiving set and in which resonance is indicated by a brilliant luminous glow on an electrode.

In general my invention comprises an envelope having within it a straight thermionic cathode having two separate electron emitting sections around one of which are positioned at least one grid and an anode. Around the other section are mounted the visual tuning indicator elements comprising a straight control electrode preferably in the form of a rod parallel to the cathode, and an anode which may be flat or preferably cylindrical and may be of very thin sheet metal or of thicker sheet material having an opening covered by very thin sheet material or foil which becomes incandescent in response to electron bombardment. In operation the electrons flow from the cathode to the anode with sufficient velocity to bombard the thin sheet metal and render it incandescent. The control electrode is electrically connected to the anode surrounding the grid and the elements of the tube are so connected in a radio receiving circuit that when the circuit is tuned to resonance with an incoming signal the incandescent portion of the indicator anode is of a predetermined size. In one form of the device the connection is such that the incandescent portion of the anode is of a maximum width when the circuit is tuned to resonance, the height remaining constant.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims, but the invention itself will best be understood by reference to the following description taken in connection with the accompanying drawing in which Figure 1 shows an electron discharge device embodying my invention with parts broken away to show details of construction; Figures 2*a* and 2*b* and 3*a* and 3*b* are top views and side views of the tuning indicator portions of Figure 1 graphically showing changes in the light pattern in response to different voltage changes, and Figure 4 is a circuit embodying the electron discharge device shown in Figure 1.

The electron discharge device or tuning indicator tube shown in Figure 1 comprises an evacuated envelope 10 provided with the usual stem and press 11, and base 12. Supported from the press are a cathode 13, preferably the conventional indirectly heated equipotential type, a grid 14 and anode 15 surrounding the cathode.

In accordance with my invention I mount in the dome portion of the envelope 10 the visual indicating portion of the tube comprising a cathode, a rod-like control electrode and an anode in the form of an open ended sheet metal cylinder surrounding said cathode and control electrode and provided with a portion of very thin sheet metal which becomes incandescent when subjected to electron bombardment. While the entire anode may be of very thin material which becomes incandescent, I prefer to make it of thicker sheet material having a window or opening covered with very thin sheet material or foil which becomes incandescent when subjected to electron bombardment.

In Figure 1 the cathode 13 is extended into the dome portion of the envelope and has a second emitting section 16 for supplying the electrons in the visual indicating device. This section preferably covers only a small angle of the surface of the cathode facing the window in the anode. A control electrode 17, which may be a rod-like member or of sheet material set edgewise to the cathode, is supported from a cross bar 18 electrically connected to the side rods 19 of the anode 15. This control electrode determines the pattern of the incandescent portion of the anode 20, which is provided with the thin sheet metal window or target 21, and is supported by rods 22 extending from the press.

This thin sheet metal or foil may be nickel from .00005" to .00025". It can be made for example by plating nickel on molybdenum or nichrome and then stripping it. The thin sheet metal may also be a tantalum film or foil rolled to from .00003" to .00005".

In operation the voltage on the anode 15 is applied to the control electrode 17, the voltage on this electrode determining the width of the pattern of light on the thin sheet metal 21 of the anode 20, the height of the pattern of light being constant and equal to the height of the window in the anode covered by the thin sheet metal.

Referring to Figure 2, which shows a top view of the tuning indicator portion of the invention

shown in Figure 1, the beam control electrode 17 is so biased that when no signal is being received the voltage difference between the control electrode 17 and the anode 20 is such that the portion 21 of the anode between the broken lines *d* not reached by electrons is dark and between broken lines *e* reached by electrons a dull red. As the set is tuned to resonance the voltage difference between the anode 20 and the electrode 17 becomes less, so that the control effect of the electrode 17 on the electrons leaving the cathode 16 is less, permitting electrons from the cathode 16 to reach more of the thin sheet metal portion 21 of the anode 20. When the set is tuned to resonance, the beam control electrode 17 is made so positive that the edges of the beam from the cathode overlap each other as shown at *f* in Figure 3. The result is that at the overlapping sections the thin sheet metal becomes incandescent so that the light from this section is made more intense than on other portions of the thin sheet metal which are a dull red. Of course the remainder of the anode 20 remains dark at all times.

The eye is sensitive to temperature changes in metal just above dull red, and hence the tuning condition is made strikingly apparent by overlap and the incandescent condition resulting therefrom. The constants of the circuits with which the tube is used can be so chosen that the maximum overlap which occurs at resonance is of any predetermined width within limits. That is, resonance can be indicated by a very fine line incandescent pattern of light or can have some width up to a large section of the target or thin sheet metal portion 21 of anode 20.

The application of an electron discharge device made in accordance with my invention to a radio circuit is shown in Figure 4. Normally the anode 15 of the triode section of the tube is electrically connected thru a resistor 40, to a source of voltage 41. The indicator anode 20 is connected directly to the source of voltage 41. With no voltage on the grid 14 a certain predetermined amount of current flow thru the triode section of the tube causes a drop in resistor 40, so that the voltages applied to anode 15 and indicator anode 20 have the greatest differential, the voltage on anode 15 being at the lower potential. The voltage on anode 20 does not change while that on the anode 15 decreases, due to the drop thru resistor 40. This makes the control electrode 17 negative with respect to anode 20, thus preventing overlap and incandescence of target 21 of the anode 20. As the voltage on the control grid 14 increases in the negative direction the current flow to the anode 15 decreases so that the voltage drop thru the resistor 40 decreases. Under these circumstances the voltage differential between anode 15 and indicating anode 20 decreases so that the control electrode 17 becomes less negative with respect to the anode 20. This permits the width of the dull red portion to increase. Thus the dull red portion increases as the negative bias on the control grid 13 increases until overlap and incandescence results. This characteristic of the tuning indicator tube is made use of when connected to a conventional automatic volume control circuit. The rectifier tube 42 has an anode 43 connected to one side of the radio frequency or intermediate frequency transformer 44 coupled to the receiving circuit not shown, and a cathode 45 connected thru a grid leak 46 and by-pass condenser 47 to the other side of the transformer 44. The cathode side of the transformer 44 is connected thru resistor 48 to control grid 14 of the tuning indicator tube. A radio frequency by-passing condenser 49 connects the grid to ground, and the conductor 50 may be connected to other parts of the circuit to provide automatic volume control. As the receiving circuit is tuned to resonance and rectification takes place thru the tube 42, the cathode side of the radio frequency transformer becomes negative with respect to ground due to the current thru resistor 46. This negative voltage is applied to the control grid 14 as a negative bias with the result that the current thru the triode portion of the tube is reduced, thus causing the width of the incandescent portion of the tuning indicator anode 20 to increase as explained above. In this arrangement the control electrode is positive with respect to the cathode. Several advantages follow from this arrangement over that in which the control electrode is biased negatively with respect to the cathode. The boundaries of the electron beams are sharp and well defined. There can be a high concentration of electrons at the edges of the incandescent areas so that the luminosity is uniform. The high current to the incandescent portion of the target can be obtained at low voltages and hence a bright incandescence is the result. A positive control electrode is suitable for direct coupling to an amplifier, that is it may be directly connected to the plate of an amplifier tube as shown in Figure 1 for example. Furthermore, a tube made in accordance with my invention is not critical to variations in cathode temperatures and is susceptible for use with alternating and direct voltages and currents.

While I have indicated the preferred embodiment of my invention of which I am now aware and have also indicated only one specific application for which my invention may be employed, it will be apparent that my invention is by no means limited to the exact forms illustrated or the use indicated, but that many variations may be made in the particular structure used and the purpose for which it is employed without departing from the scope of my invention as set forth in the appended claims.

What I claim as new is:

1. An electron discharge device having an envelope enclosing a straight electron emitting cathode, an anode adjacent said cathode and having a target of thin sheet metal foil for receiving electrons from said cathode, and a control electrode comprising a conductor intermediate said anode and cathode for determining the portion of the target reached by electrons from said cathode.

2. An electron discharge device having an envelope, a cathode within said envelope having two electron emitting sections, an open ended tubular anode surrounding one of the electron emitting sections and provided with a section of thin sheet foil and a control electrode between said anode and said cathode and comprising a conductor parallel to the cathode for producing on the section of sheet metal foil an incandescent portion of substantially constant length and of a width depending on the voltage applied to said control electrode, a grid and a second anode surrounding the other of said electron emitting sections of said cathode and an electrical connection between said second anode and said control electrode.

3. An electron discharge device having an envelope, a cathode within the envelope having a plurality of electron emitting surfaces along its

surface, a grid and anode surrounding one of said electron emitting surfaces and an open ended tubular anode surrounding another of the electron emitting surfaces of said cathode and provided with a section of thin sheet metal foil and a control electrode positioned between said section of thin sheet metal foil and the other electron emitting surface and comprising a conductor parallel to the cathode and connected to the anode surrounding the grid for producing on said section of thin sheet metal foil an incandescent portion of substantially constant length and of a width depending upon the voltage applied to said control electrode thru the anode around the grid.

4. An electron discharge device having an envelope containing a straight cathode having an emitting section extending longitudinally of but covering only a small angle of its surface, an anode surrounding the cathode and having a section of thin sheet foil opposite said emitting section for receiving electrons from the cathode in sufficient quantities to become incandescent, and a control electrode comprising a straight conductor positioned between the emitting section of said cathode and the section of thin sheet foil for determining the portion of thin sheet foil reached by electrons from said cathode in sufficient quantities to become incandescent.

HARRY C. THOMPSON.