

May 6, 1930.

H. M. STROBEL

1,757,345

RADIO TUBE

Filed Sept. 20, 1928

Fig. 1.

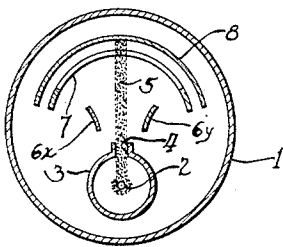


Fig. 2.

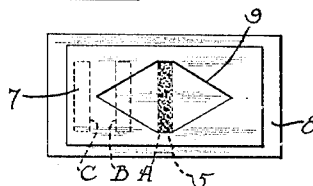


Fig. 3.

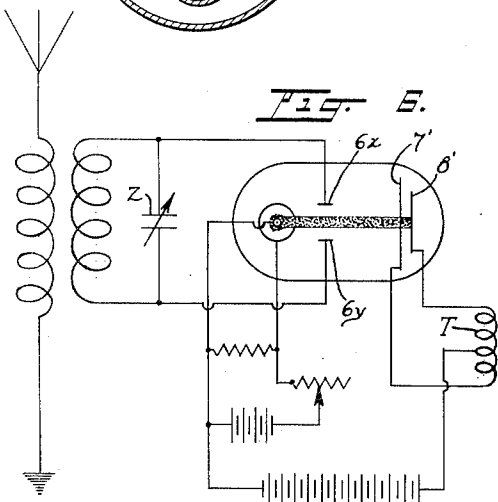


Fig. 4.

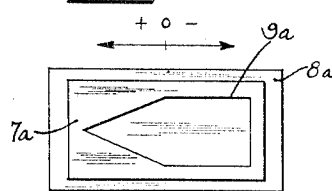


Fig. 5.

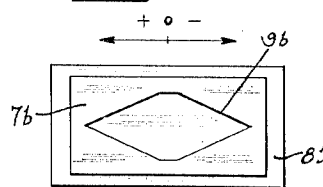


Fig. 6.

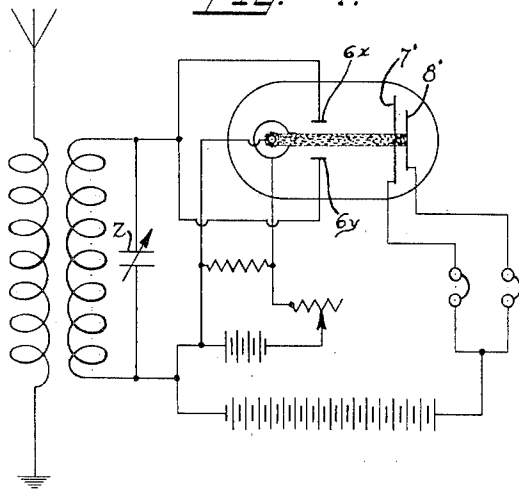
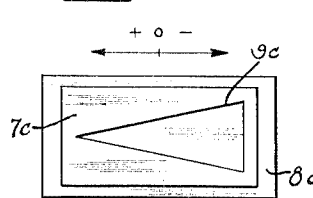


Fig. 7.



INVENTOR
H. M. Strobel
BY *Mum Leo*
ATTORNEYS

UNITED STATES PATENT OFFICE

HOWARD M. STROBEL, OF OAK PARK, ILLINOIS

RADIO TUBE

Application filed September 20, 1928. Serial No. 307,159.

My invention relates to tubes for use in wireless communication of the type commonly known as radio tubes, and it consists in the combinations, constructions, and arrangements herein described and claimed.

An object of my invention is to provide a tube which may be used in several different ways, such as a detector, an amplifier, a static eliminator, etc., due to the fact that provision is made whereby the characteristics of the tube may be changed to effect the result desired.

A further object of the invention is to provide a tube of the character described in which the changes mentioned above may be effected, without any change in the relative positions of the elements in the tube itself, by applying currents of varying potentials or different polarities to certain elements of the tube.

A further object is to provide a tube in which a filament is employed and deflector elements, and in which the plate element is constructed of a plurality of parts so arranged that a deflection of the beam from the filament will produce a corresponding change in the plate current without necessitating a relative movement of the elements themselves.

Other objects and advantages will appear in the following specification, and the novel features of the invention will be particularly pointed out in the appended claims.

My invention is illustrated in the accompanying drawings, forming part of this application, in which

Figure 1 is a plan view showing the relative arrangement of the elements,

Figure 2 is a face view of the plate members,

Figures 3, 4, and 5 are modified views of the plate elements,

Figure 6 is a view showing a typical circuit with which the tube may be used, and

Figure 7 is a modified form of circuit.

Referring now particularly to Figure 1, I have shown therein a tube constructed according to my invention. This consists of a casing 1 in which is disposed a filament 2. Around this filament is a metal cylinder 3,

preferably of nickel, having an outlet 4 for the beam 5, as will be explained later. On opposite sides of the beam are grids or fences 6^x and 6^y, respectively. The plate element consists of two portions, which I have indicated at 7 and 8, respectively. These elements are insulated from one another and may be curved, as shown in Figure 1, or may be arranged in parallel relation, as shown at 7' and 8' in Figures 6 and 7.

As will be seen from Figure 2, the plate element 7, which is nearest the filament, may be provided with a substantially diamond-shaped opening 9. The outlet slot or opening 4 of the cylindrical shield 3 is of such a length that the beam 5, under certain conditions, will just be received on the major axis of the diamond, as shown in Figure 2.

The whole theory upon which the tube works is that the variation of the electron beam received by that plate nearest the filament, which for sake of a better term I have called the "live" plate, and the plate 8 to the rear, which I term the "dead" plate, gives rise to conditions which effect a change of plate current. The change in the effective electron beam reaching the two plates is caused by the shifting of the beam through the medium of the grids or fences. In Figure 2 the beam is shown in the central position marked A. In this position the two fences 6^x and 6^y are neutral and the entire beam passes through the opening 9 and impinges on the dead plate 8. If, however, the left fence 6^x is made positive or the right fence negative, either separately or together, the result would be to swing the electron beam to the left, causing it to strike the live and dead plates at B. It is possible to increase the fence potentials further to cause the beam to swing entirely free of the opening 9 onto the live plate.

This property gives rise to many possibilities. From an inspection of Figure 6, it will be observed that the dead plate 8' which corresponds to the plate 8 of Figure 2, is put at a positive potential by a separate battery lead of its own. Therefore, it will take any electrons that have not struck the live plate and will prevent them from returning to the live plate. In this way the space within the tube

is kept clear of free electrons and space charge effects, thus preventing the "mushing" action of the live plate. The live plate is also at a positive potential, and the external circuit may be used to operate an amplified tube, as shown in Figure 6.

Referring again to Figure 2, it will be seen that at the position A there is no live plate current but full current in the dead plate circuit. At position B half the total beam current is in each plate circuit, while at C all the beam current is in the live plate circuit. The plate current in one plate circuit increases only as the current in the other plate circuit decreases. This characteristic of the output of the tube may be used to produce an accumulative effect in the secondary of a coupling transformer. If the tube is operated by applying radio frequency oscillations to one of the fences, the other being neutral, or is so connected to the radio frequency oscillation coil or condenser as to always have a charge opposing that on the other fence, then for each alternation of the radio oscillations, the beam will be deflected onto the live plate, negative charges of the alternations swinging the beam to the right when the left fence has a negative charge, while positive alternations swing it to the left. It will be observed that though the fences are excited with radio oscillations, that each alternation tends to increase the plate current above neutral position.

If the right fence is biased negative sufficiently so as to deflect the beam to the position B and radio oscillations are impressed on the left fence, then positive alternations will tend to increase the plate current of the live plate 7 by swinging the beam toward position C, while negative alternations will tend to decrease the live plate's current by swinging the beam toward the neutral position. During this, of course, the negative bias on the right fence is constant. The resulting live plate current is a direct current pulsating at radio frequency. Used in this way, the tube may serve as an amplifier.

In order to enable the tube to operate over a wider range as an amplifier, the opening may be half diamond shape, as shown at 9^c in Figure 5.

The live plate may be so cut that for regular fence voltage variations there will also be a regular corresponding plate current variation. It is possible to so cut the plate that "straight" fence voltage increases or decreases will cause a logarithmic increase or decrease in plate current.

To cause the plate current to increase more than in direct proportion to a given fence voltage increase, the point or space on the live plate where the beam falls, for that given fence voltage, is made sufficiently large to give the extra plate current desired. To decrease the plate current at that point of the

live plate, the plate area would be correspondingly reduced. Thus, by properly cutting the plates, tubes having special characteristic curves for special purposes may be accurately made. I have already mentioned that a plate cut as in Figure 5 would be a perfect amplifier, having no distortion. Defects of the tube, such as ionization and increased electron flow at certain fence voltages, or uneven deflections of the beam for even voltage variations, may likewise be neutralized by properly designing the plate, thus still retaining the plate curve perfect.

In Figure 4 I have shown the form of the cut of the live plate 7^b which is best suited as a static eliminator, for it will be observed that when the beam moves to the end of the cut 9^b, there will be no more plate current variations as long as the beam is not deflected off of the live plate. It is merely a question of extending this live plate to prevent the beam from passing off the end. Thus it will be seen that excessive variations, such as those produced by static impulses, will to a large extent be eliminated.

In Figure 6 I have shown a typical circuit connection in which the plate connections are made to a transformer T having a center tap so that when the current increases in one half of the transformer coil and decreases in the other half, the corresponding fields will produce an accumulative effect in the transformer secondary. In this Figure it will be observed that the fences 6^x and 6^y are connected one on each side of the condenser Z of the tuning circuit. Consequently, when the upper condenser plate is charged positive, the fence 6^x is also positive, while the opposite fence will be negative. Therefore, the fence charges, as well as the frequency, depend upon the oscillations received in the tuned circuit.

In Figure 7 both fences are joined together and connected to the tuned circuit. Both will then have the same charge, be it positive or negative. When the fences are positive, they will cause the beam of electrons to spread out fanwise or diverge, thereby increasing the cross sectional area of the beam by decreasing the electron density. When the fences are charged negatively, the opposite effects as to cross sectional area and density are produced. The tube thus provides a means for varying the cross sectional area of the beam, even though the total plate current is the same. Consequently, since a variation of the cross sectional area of the beam varies the portion of the beam impinging on the live plate, the current in the live plate circuit is caused to vary as the fence charges and potentials.

I claim:

1. A radio tube comprising a casing, a filament within the casing for emitting electronic rays, means for directing the rays to

form a beam, means for deflecting the beam, and a plate element for receiving the beam, said plate element consisting of a pair of plates spaced apart and insulated from one another, one of said plates having an elongated opening to permit a portion of the beam to impinge on the other plate, a portion of said opening having converging edges whereby the shifting of the beam toward the narrower end of the opening will cause more of the electrons to impinge on the plate having the opening and less on the other plate.

2. A radio tube comprising a casing, a filament within the casing for emitting electronic rays, a shield for said filament having an outlet opening for directing the rays to form a beam, means for deflecting the beam, and a plate element consisting of a pair of plates spaced apart and insulated from one another, the plate nearer the filament having an opening, said opening having edges converging toward an apex disposed in the central major axis of the opening whereby, when the beam is deflected along said major axis, the number of electrons impinging on the plate having the opening will increase and the number on the other plate will decrease.

3. A radio tube comprising a casing, a filament within the casing for emitting electronic rays, a cylindrical metallic shield disposed around said filament and having a slot on one side for directing the rays to form a beam, a deflecting plate on each side of the path of the beam, and a plate element consisting of a pair of parallel plates disposed substantially at right angles to the path of the beam, the plate nearer the filament having an elongated opening provided with converging edges at its opposite ends, the central portion of the opening being in the normal central axis of the beam whereby the shifting of the beam laterally in either direction along the major axis of the opening will cause a greater number of electrons to impinge on the plate having the opening and a less number to impinge on the other plate.

4. A radio tube comprising a casing, a cathode within the casing for emitting electronic rays, means for directing the rays to form a beam, means for deflecting the beam, and means for receiving said beam comprising spaced apart plates disposed substantially at right angles to the path of the beam, the plate nearest the cathode here called a live plate, acting as a screen to vary the amount of projection of said beam upon the plate farthest away from the said cathode and here called the dead plate, whereby a deflection of the beam from the neutral position will cause the current received by said live plate to either decrease, increase or remain constant, depending respectively on whether the area of said live plate that is struck by

the beam decreases, increases or remains constant.

Signed at Chicago, in the county of Cook and State of Illinois, this 15th day of September, A. D. 1928.

HOWARD M. STROBEL.

76

75

80

85

90

95

100

105

110

115

120

125

130