Jan. 17, 1956 G. H. KRAWINKEL 2,731,560

ELECTRON TUBE WITH DEFLECTION CONTROL

Filed Feb. 5, 1953

2 Sheets-Sheet 1

FIG. 1.

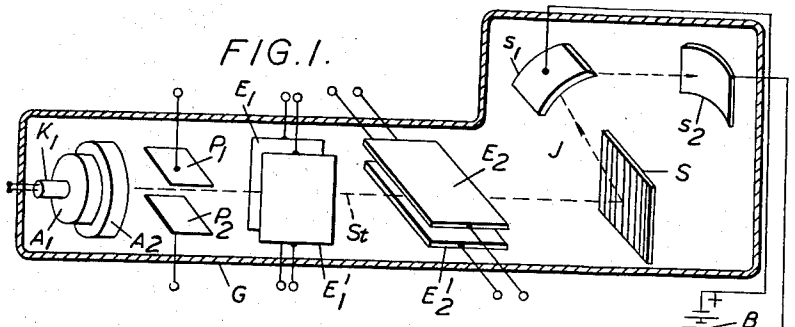


FIG 2

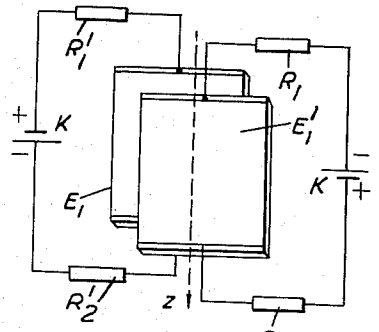


FIG. 3.

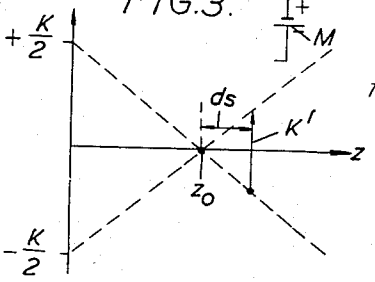


FIG 4

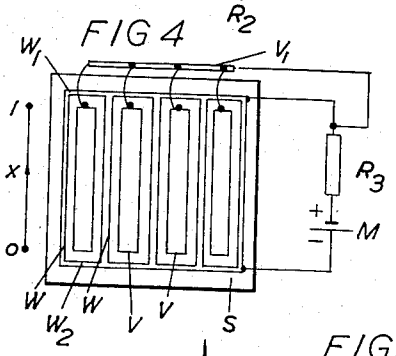


FIG. 6.

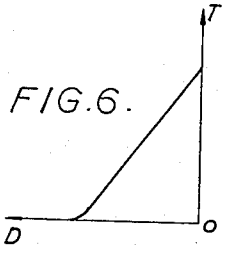
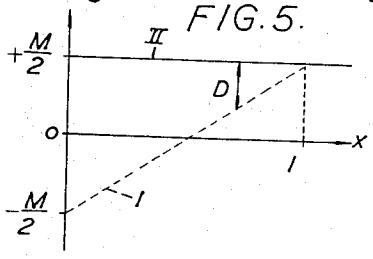


FIG. 5.



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2 Sheets-Sheet 2

FIG. 7.

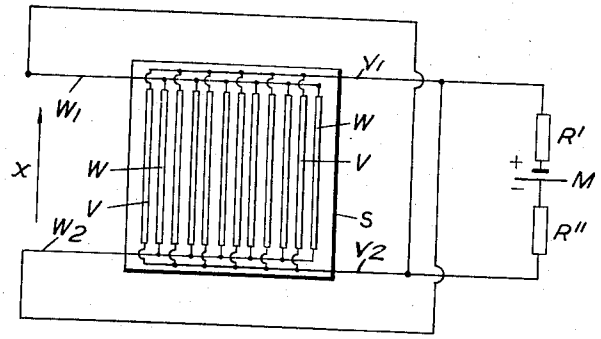


FIG. 8.

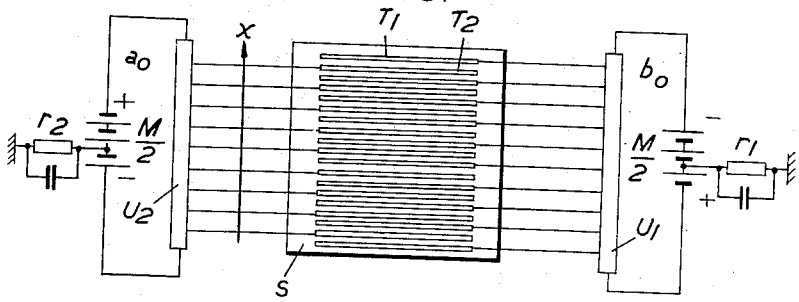


FIG. 9.

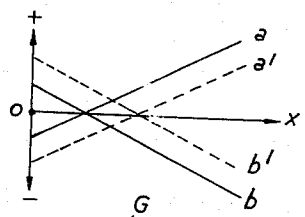


FIG. 10.

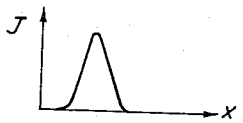
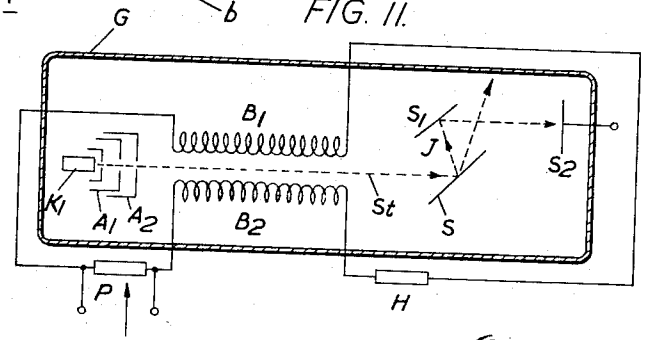


FIG. 11.



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United States Patent Office 2,731,560 Patented Jan. 17, 1956

2,731,560

ELECTRON TUBE WITH DEFLECTION CONTROL

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Application February 5, 1953, Serial No. 335,283

Claims priority, application Germany February 5, 1952

10 Claims. (Cl. 250—27)

The present invention relates to electron tubes with deflection control, wherein an electron beam is controlled, i. e. influenced in its direction by means of an electric or magnetic deflecting field, i. e. through a field transverse to the direction of flow of electrons. In such tubes, a displacement of the point where the electron beam impinges upon a target electrode or upon a combination of such electrodes, renders a measure for the deflecting voltage or deflecting currents. The movement of the point where the beam strikes the target may be utilised for producing a voltage or current increase within an appropriate output circuit connected to the target electrode. There may be cases where only the magnitude of the deflection is of interest or only the fact that a deflection of the electron beam has occurred. The occurrence of a deflection as well as its magnitude may be ascertained or measured with a suitably designed target electrode.

One disadvantage of conventional arrangements of this type is to be seen in that the deflection-control sensitivity and with it the displacement of the point where the target is hit are extremely small, unless extremely long paths for the electron beam are used which are difficult to handle and to operate.

A further disadvantage of the known arrangements resides in that it is necessary to adjust very carefully and accurately the point where the electron beam strikes the target electrode or electrodes, so that it should be possible to ascertain even very small displacements of the said point.

It is the object of the present invention to avoid the above mentioned drawbacks of electron tubes with deflection control; and it is a particular object to provide on the one hand an amplification of the deflection, and on the other hand a target arrangement for the beam which enables a uniform deflection indication of the beam within any optional range of the target electrode.

In order that the invention may be clearly understood and readily carried into practice, some embodiments thereof will now be described by way of example with reference to the accompanying drawings, wherein

Fig. 1 shows schematically a longitudinal section of the tube according to the invention, the individual component parts being represented in a perspective manner.

Fig. 2 is also a perspective representation, but on an enlarged scale, of one part of the tube shown in Fig. 1 together with the appropriate circuit connections.

Fig. 3 serves for explaining the function of the arrangement according to Fig. 2.

Fig. 4 shows in more detail another component part, with the appropriate circuit, of the tube according to Fig. 1.

Figs. 5 and 6 serve for the explanation of the function of the arrangement shown in Fig. 4.

Figs. 7 and 8 represent some modifications of one of the component parts of the tube according to Fig. 1.

Figs. 9 and 10 serve for the explanation of the function of the arrangement according to Fig. 8, and

Fig. 11 shows a longitudinal section of a modified tube.

As shown, within an evacuated vessel G an electron beam St is produced by means of an electron beam generator K_1—A_1—A_2, which may be of any conventional design. The electron beam passes in succession through the electrode arrangements P_1—P_2, E_1—E'_1, E_2—E'_2, and it then strikes the electrode S. The electrode system P_1—P_2 is constituted by a deflecting condenser to which the voltage is applied which is to be magnified, rectified or modulated. The electrode system E_1—E'_1 is a deflection magnifier which is shown in more detail in Fig. 2. Both plates E_1 and E'_1 (Fig. 2), between which the electron beam passes, consist of a resistance material which may be either self supporting or may be applied to a carrier by evaporation, by chemical deposition or in a mechanical manner. To the terminals of each of the plates E_1 and E'_1 a direct current voltage K is connected through resistances R_1, R_2, and R'_1, R'_2 respectively in such a manner that at both plates E_1 and E'_1 voltage drops are set up in opposite directions. These two oppositely set up voltage drops are once more indicated in Fig. 3 over the direction z which is transverse with respect to the plates E_1 and E'_1. It will be appreciated that in the z-direction there will be a point z_0, depending upon the magnitude of the resistances R_1, R_2, R'_1 and R'_2 (Fig. 2), where there will be no deflecting field between E_1 and E'_1 for an electron beam through the system at right angles to the direction z. Although the electron beam does not pass through the point z_0 between the plates E_1 and E'_1, as the desired effect, to be described hereinafter, is obtained even if the beam passes through other points along the z-axis of Fig. 3, it will be assumed for the explanation of the deflection magnification that the electron beam passes through the point z_0 between the plates E_1 and E'_1 (Figs. 2 and 3). Now, if the electron beam St is deflected the distance ds in the direction z of Figs. 2 and 3 due to deflecting field set up at the control condenser P_1—P_2, then the beam is subjected, as indicated in Fig. 3, to a deflecting field K' between the plates E_1 and E'_1. By a suitable choice of the magnitude of the voltage K at the plates E_1 and E'_1 (Fig. 2), it is obviously possible to obtain by the influence of the voltage K' in Fig. 3 a deflection of the beam St in a direction perpendicular to ds which is substantially larger than, but proportional to, the deflection ds. The beam, additionally deflected in the direction of K', now enters the space between the two plates E_2 and E'_2 as shown in Fig. 1, which are constructed in a similar manner as the plates E_1 and E'_1, i. e. that they form resistances and are connected to voltage sources as described with reference to Fig. 2. However, the position of the plates E_2 and E'_2 is at right angles with respect to the direction of the plates E_1 and E'_1, but also transverse with respect to the longitudinal axis of the tube. The beam which, due to its original deflection ds has been deflected in the system E_1, E'_1 under the influence of the field K' (Fig. 3) in a direction perpendicular to ds, now enters with a deflection, which may be designated ds', the space between the plates E_2 and E'_2 and it is there subjected to a further deflection amplification in a similar manner as described with reference to Fig. 3. In view of the cross-wise disposition of the plates E_2 and E'_2 with respect to the plates E_1 and E'_1, the deflection ds' of the beam, which occurs between the plates E_2 and E'_2, has the same direction with respect to the plates E_2 and E'_2 as the deflection ds with respect to the plates E_1 and E'_1. As a result of the voltage drop at the plates E_2 and E'_2, the beam is subjected to a deflection between these plates which is proportional to ds' but perpendicular to

the direction of *ds'*, whereby the beam is again deflected in the direction of the original deflection *ds*. Naturally, any number of such plate systems may be used for a deflection amplification, the individual systems being arranged in succession with alternately cross-wise arranged plates. A correspondingly amplified deflection of the electron beam will result which is proportional to the deflection control at the plates P_1, P'_2.

The electron beam, which has been subjected to a deflection control and the deflection of which has been amplified as described, now impinges upon an electrode S adapted to ascertain the beam deflection, as shown in Fig. 1. This electrode is basically an electrode adapted to emit secondary electrons, and its characterising feature is to be seen in that the emission of these secondary electrons, liberated by the electron beam S*t*, is dependent upon the location of the point where the electron beam strikes the electrode S. This function will now be described in more detail with reference to the arrangement shown by way of example in Fig. 4. The plate S may be made of insulating material and is equipped with two systems of strips. The strip system V, which is connected to a collecting bar V_1 represents the secondary electrons emitting electrode proper. Adjacent to each strip V, at the right as well as at the left of it, a strip W is disposed. The strips W, which are insulated from the strips V, consist of resistance material and their ends are connected to two collecting bars W_1 and W_2. To the collecting bars W_1 and W_2 is applied, for instance through a series resistance R_3, a direct current voltage M. Thus a voltage drop from $-M/2$ to $+M/2$ is set up along the strips W (Fig. 5). The collecting bar V_1 of the strip system V may be connected to the plus pole of the direct voltage M. Between the electrode S and another electrode s_1 (Fig. 1), to which a positive potential B with respect to the electrode S is applied, a suction field in the direction towards s_1 is established. The electron beam S*t* liberates, when impinging upon the electrode S, secondary electrons. These secondary electrons are subjected to the influence of two fields: firstly, to the field between the strip systems V and W, the intensity of which varies in the direction *x* (Fig. 4), and secondly, to the suction field which is directed from S toward s_1. The effect of these two fields upon the liberated secondary electrons is easily understood. In the direction *x* (Fig. 4) of the deflection of the electron beam at the electrode S, the released secondary electrons are under the influence of a field between the strips W and V the intensity of which decreases from the lower to the upper end of the electrode. Superposed on this varying field between W and V is the suction field established by the voltage source B between S and s_1. The field between W and V, which varies in the direction *x*, is determined by the direct current voltage M (Fig. 4). It will be appreciated that by a suitable choice of the magnitude of M in relation to the voltage B applied to s_1, which determines the suction field (Fig. 1), it can be reached that all secondary electrons released in the lower part of the structure S as shown in Fig. 4 will travel to the strip W under the influence of the field between V and W. However, if the point where the electron beam S*t* strikes the electrode is shifted upwards in the direction *x* (Fig. 4) then first the electrons with high velocity and later, as the said point moves upwards, also the electrons of lower velocity will move towards the electrode s_1 under the influence of the suction field (Fig. 1). The variation of the voltage from $-M/2$ to $+M/2$ along the resistance strips W is indicated in Fig. 5 by the dotted straight line I, and the constant voltage of the strips V at $+M/2$ is represented by the straight line II over the direction *x*. As indicated the secondary electrons, released by the electron beam S*t*, are under the influence of a varying counter field D, which causes their movement towards the electrode s_1 (Fig. 1), the said counter field being different in respect to each magnitude *x* (Fig. 5). Fig. 6 indicates the course of the stream J of secondary electrons moving from the electrode S towards the collecting electrode s_1 (Fig. 1), which is dependent upon the displacement in the direction *x* of the point where the electron beam impinges upon the electrode S.

The stream J of secondary electrons, the intensity of which has been controlled as described, can now be utilised directly at the electrode s_1, or as an amplified stream after it has been subjected to a multiplication of the secondary emission in a manner known per se. Fig. 1 represents schematically a one-stage multiplication of the secondary electrons without limiting the invention to the shown arrangement. Thus, the electrode s_1 may form an electrode adapted to emit secondary electrons instead of being a collecting electrode only. With a one-stage multiplication of the secondary emission, the electrode s_2 then represents the collecting electrode. To the latter a resistance *r* may be connected from which the amplified signal may be derived.

The methods and arrangements according to the invention are adapted to avoid the usual difficulties of adjusting electron tubes with deflection control, in view of the fact that the described deflection amplification is equally effective at each point of the deflection amplifiers (E-systems) through which the electron beam passes, and only an additional constant deflection has to be taken into consideration if the electron beam does not pass through the point z_0 of one of the E-systems. Such a constant deflection does not affect the function of the apparatus, as the device, which ascertains the displacement of the point where the deflection controlled electron beam impinges upon the electrode S, renders an equal displacement indication however large the surface of the electrode is.

The second limitation of the conventional tubes with deflection control, that is their low control sensitivity is overcome by the arrangement of the deflection amplifiers that is by the plate systems E_1, E_1' and E_2, E_2'.

A continuous variation of the degree of amplification is possible for instance by variation of the constant-current voltage K at the deflection-amplification systems E_1, E_1', E_2, E_2'.

In view of the fact that the characteristic of the current J starts with a bend (Fig. 6), it is possible to use the tube, when adjusted to work at this point of the characteristic, for rectification or modulation purposes. A shifting of the working point along the characteristic can be effected for instance by an additional direct-current voltage applied to the system E_2 of the arrangement represented as an example in Fig. 1, or by the application of an additional direct-current voltage to the control condenser P. A modulation with a different oscillation may be obtained for instance by superposing the direct current voltage M applied to one of the deflection amplifiers with an auxiliary oscillation, or alternatively by modulating the intensity of the beam in the beam generating system K_1, A_1, A_2 with the auxiliary oscillations.

It is possible to increase the sensitivity of the device for ascertaining the displacement of the point where the beam impinges upon the target electrode, if within the above mentioned secondary-emission multiplier the electrode s_1 following the first secondary emission electrode S is designed in the same manner as the latter. In this manner, a multiplication of the effect of two devices for the deflection indication is obtained, and if also the electrode s_2 is designed in the same manner as the electrode S, then the combined effect of three deflection indicating devices results.

The application of the described deflection amplifier (systems E) and of the deflection-indicating systems (one or more electrodes S) according to the invention may be applied independently of one another. It is possible to use the deflection amplification according to the invention in combination with any well known deflection-indicating means, and also the means according to the invention for indicating the deflection of an elec-

tron beam may be used independently of the other devices described hereinbefore by way of example.

The deflection indicating means according to Figs. 4 to 6 have the property that the electron beam releases secondary electrons at an electrode S, and the movement of these electrons towards the suction electrode s_1 is influenced by means of electric fields in such a manner that at least one of these fields causes a locally varying emission of secondary electrons, i. e. varying over the whole surface of the secondary-emission electrode S. In order to prevent with such an arrangement that the electron beam, which has been subjected to the deflection control, when it approached the electrode S is itself influenced at different points of this indicating arrangement by different fields, it is advisable to design the deflection-indicating device symmetrically with respect to the electrodes which produce the locally varying field influencing the emission of secondary electrodes.

Such a symmetrically designed electrode arrangement for the deflection indication of a deflection controlled electron tube is shown by way of example in Fig. 7. Two strip systems V and W are arranged upon an insulating plate S, and the individual strips which may consist of a suitable resistance material, alternate like two combs shifted one into the other. The system of strips V is arranged between collecting bars V_1 and V_2, whilst the system of strips W is connected to collecting bars W_1 and W_2. The collecting bars W_1, W_2 and V_1, V_2 respectively are connected in an opposite sense to the voltage source M. Thus, along the resistance strips V a voltage drop is set up having at the top the highest positive value and at the bottom the lowest negative voltage value, whilst at the system of strips W a voltage drop from the top towards the bottom from negative to positive voltage values is established. If now the strip systems V and W respectively comprise a great number of individual strips, then the voltage values at the individual strips cancel one another in respect of the approaching deflection controlled electron beam up to a point directly in front of the deflection-indicating device, whilst the secondary electrodes released at the electrodes V and W, when they are struck by the deflection-controlled electron beam, are subjected to the influence of the field between the electrodes V and W. At the upper end of the strips this field is directed from the W-electrodes to the V-electrodes. At the lower end of the plate this field is directed from the V-electrodes towards the W-electrodes. In the centre of the plate a zone subsists where there is no field between the V-electrodes and the W-electrodes. If the number of strips of which the systems of V-electrodes and W-electrodes are formed is sufficiently great, it is obvious that the same conditions between the V-electrodes and W-electrodes prevail above and below the field-free central zone in respect of the secondary electrons released by the deflection controlled electron beam. This is due to the fact that the liberated secondary electrons will travel above and below the field-free zone to the positively biased electrodes, whilst they are free to travel from the field-free central zone to a suction electrode under the influence of a suction field established in front of the whole deflection indicating system, and the suction electrode may be constituted for instance by an input electrode of a secondary-emission multiplier as hereinbefore described with reference to Fig. 1. In order to avoid undesired charges to be set up upon the insulating surfaces between the individual V-electrodes and W-electrodes caused by the arrival of the primary electron beam, it may be convenient to make the carrier plate S or at least its surface of a semi-conductive material, such as for instance glass of a suitable composition.

The stream of secondary electrons leaving the deflection-indicating device and designated J in Figs. 1 to 6,

has a rising characteristic if the beam approaches the field-free central zone as a result of the movement of the primary electron beam in the direction x (Fig. 7) under the influence of the hereinbefore described different fields, and the characteristic has a dropping course when the beam moves away from the central zone.

In Fig. 8 is an arrangement indicated which, it is true, results in a stepped voltage characteristic between the two electrode systems in the direction of the beam deflection, but in this case it is no longer necessary to make the electrode systems proper of resistance material. With regard to the desired high secondary emission ratio of the whole arrangement, this may be even an advantage compared with the arrangement shown in Fig. 7. As shown, upon a plate S, made of a resistance material or of a semi-conductive material, the two comb-like disposed electrode systems T_1 and T_2 are arranged which are connected alternately to resistances U_1 and U_2. Across the resistances U_1 and U_2 the voltages

$$\begin{matrix} -M \\ \hline +2 \end{matrix} \quad \text{and} \quad \begin{matrix} +M \\ \hline -2 \end{matrix}$$

are connected so that also in this case at the upper edge of the plate a voltage M subsists between the two electrode systems directed from — to +, and at the lower edge of the plate the same voltage directed from + to —. In the centre of the two electrode systems again a field-free zone is established. In addition, the voltages in the current circuits a_0 and b_0 are connected through resistances r_2 and r_1 to a fixed potential (ground) as shown in Fig. 8. Fig. 9 indicates by full drawn lines a and b the voltage conditions over the direction x (Fig. 8) which subsist between the strip-shaped electrode systems of Fig. 8. As shown in Fig. 9, the field-free zone of the arrangement is to be found at the intersection of the lines a and b. The effect of the arrangement according to Fig. 8 upon the electron stream produced by the deflection-controlled electron beam at the deflection indicating device and moving away from the latter, is the same as hereinbefore described with reference to Fig. 7. Fig. 10 indicates the characteristic of the stream J of secondary electrons over the direction x as it varies in dependence upon the position of the target point of the deflection-controlled electron beam.

If the tube is to be used as an amplifier, then a working point on the rising or dropping flank of the characteristic shown in Fig. 10 is to be adjusted. On the other hand, if the tube is intended to be used as a modulator or as a demodulator, then its working point has to be adjusted either at the lower bends or at the peak of the characteristic of Fig. 10. If the deflection-controlled primary beam deviates unintentionally from the chosen working point, then it is possible to adjust the working point by means of cathode resistances traversed by the output current as in the case of conventional amplifying tubes. In addition, it is possible to adjust the working point with respect to a deviating primary beam in such a manner that either the magnitude of voltages at the electrode systems of the deflection-indicating device or their relation to a rest potential (ground) are made dependent on the output current or dependent on intermediate currents if secondary-emission multipliers are used. If, for instance, the resistances R_1 and R_2, as indicated in Fig. 2, are traversed by the output current or by any intermediate current of a succeeding secondary emission multiplier in such a manner that a negative voltage towards ground is set up at the resistance R_1 and an equally large positive voltage with respect to ground is set up at the resistance R_2, then the voltage

free zone at the deflection-indicating device is shifted in the x-direction into that position which is indicated in Fig. 9 by the dotted lines a' and b'. Thus the working point of the deflection-indicating device can be shifted by the use of well known circuit arrangements so that it follows an unintentional deviation of the deflection-controlled primary electron beam. Thus, the present deflection-control electron tube avoids, as already mentioned, the well known difficulties in connection with the adjustment of the electron beam.

The sensitivity of the deflection control according to the invention may be still further increased, if the deflection control is performed by an arrangement shown in Fig. 11. Within the evacuated vessel G are arranged a beam generating system K_1, A_1, A_2, a deflection indicating device S and, if desired, a secondary-emission multiplier, which is indicated schematically by the two electrodes s_1 and s_2. The deflection condensers P_1, P_2 of Fig. 1 are replaced, however, in Fig. 11 for instance by the two coils B_1 and B_2, the axes of which are parallel with respect to the electron beam St. To the input end of both coils the voltage or oscillation P may be applied, which is intended to bring about the deflection control. The velocity of propagation of this voltage along the coils B_1 and B_2 should be the same as the velocity of the electrons in the beam St. Between the parts of the coils B_1 and B_2 facing each other a deflecting field subsists which influences the electrons of the beam St, and this field moves along the coils B_1 and B_2 with the same velocity as the electrons of the beam. Thus, the beam electrons are subjected to the deflection effect along the whole axial length of the device B_1—B_2. With the arrangement shown in Fig. 11, the velocity of propagation along B_1 and B_2 is determined by the propagation constant, which on its part is dependent upon the distributed winding inductivities and winding capacities of B_1 and B_2. However, it is also possible to design the members B_1 and B_2 in a manner known per se as chain conductors with concentrated inductivities and capacities so that for instance the partial capacities in close succession perform the deflection control of the electron beam. Naturally, also in this case the propagation constant of the arrangement has to be chosen such that the velocity of propagation along the chain conductors is equal to the velocity of propagation of the electrons in the beam St.

Moreover, Fig. 11 indicates an advantageous orientation of the deflection-indicating device S with respect to the incoming primary beam St. The primary beam St releases at the deflection-indicating device not only secondary electrons represented in Fig. 11 by the stream J, but it may also cause a reflection of high velocity electrons which, due to their high velocity, when they leave the electrode S, are only influenced to a small degree by the control fields set up at this electrode. Accordingly, they may cause a flattening of the output current characteristic of the tube. In order to avoid this undesirable effect of the reflected electrons with high velocity, recourse can be had to the effect that these electrons have a preferred direction, and the deflection indicating device may accordingly be so disposed that the preferred direction of the reflected high velocity electrons avoids the collecting electrode of the succeeding secondary-emission multiplier so that the reflected high velocity electrons do not form part of the useful current and are absorbed for instance by the coating of the tube walls.

What I claim is:

1. An electron tube comprising an electron gun for emitting a focused electron beam; beam deflection means for deflecting said beam in accordance with an input signal; collection electrodes biased to collect electrons secondarily emitted by a beam target-electrode assembly, and said latter assembly comprising, a backing member; a plurality of elongated conductive elements arranged in parallel relation across the face of said backing member to form a composite beam-receiving target; and element biasing means for imposing different electric potentials on respectively adjacent elements whereby as the beam impinges on the elements causing secondary electron emission therefrom, part of the electrons emitted by the relatively more negative elements will be collected by the relatively more positive elements, the potential difference between adjacent elements being graduated in intensity across the face of the target assembly to vary the amount of secondary emission from the assembly to the collection electrodes in accordance with the position of the beam on the target assembly.

2. In a tube as set forth in claim 1, said elements comprising two sets alternately interlaced and disposed parallel to the path of deflection of the beam, the first set of electrodes being joined together and connected to the positive terminal of a source of electric potential, and the second set of electrodes being made of electrically resistive material, said second elements being all electrically connected in parallel across said source of potential to each draw a current therefrom and thereby set up a potential gradient along each element of said second set.

3. In a tube as set forth in claim 1, said elements comprising two sets alternately interlaced and disposed parallel to the path of deflection of the beam, the elements of each set being made of electrically resistive material, and the respective elements of each set being mutually connected in parallel, the first set of parallel elements being connected across a source of potential to draw current therefrom and set up a potential gradient along each element, and the second set of parallel elements being connected across said source in the opposite polarity to set up a potential gradient along each element but of opposite polarity from said first mentioned gradients.

4. In a tube as set forth in claim 1, said elements comprising two sets alternately interlaced and disposed parallel to the path of deflection of the beam, the elements of each set being made of electrically resistive material, and the respective elements of each set being mutually connected in parallel, the first set of parallel elements being connected across a source of potential to draw current therefrom and set up a potential gradient along each element, and the second set of parallel elements being connected across said source in the opposite polarity to set up a potential gradient along each element but of opposite polarity from said first mentioned gradients, there being a line transverse to the direction of deflection along which the potentials of the respective sets of elements are all the same, thereby providing the target assembly with a secondary emission characteristic having a peak at said line.

5. In a tube as set forth in claim 1, said elements comprising two sets alternately interlaced and disposed normal to the path of deflection of the beam; a chain of resistors being associated with each set of elements and the resistors being connected in series in each chain and across a source of potential, one chain being connected in opposite polarity with respect to the other chain, and the elements of each set being individually connected to taps between the resistors of the associated chain whereby the potentials on the elements of one set will increase in steps in one direction, and the potentials on the elements of the other set will decrease in steps in the same direction.

6. In a tube as set forth in claim 1, said elements comprising two sets alternately interlaced and disposed parallel to the path of deflection of the beam, the elements of each set being made of electrically resistive material, and the respective elements of each set being mutually connected in parallel, the first set of parallel elements being connected across a source of potential to draw current therefrom and set up a potential gradient along each element, and the second set of parallel elements being connected across said source in the opposite polarity to set up potential gradient along each element but of opposite polarity from said first mentioned gradients, there

being in the center of the assembly a line transverse to the direction of deflection along which the potentials of the respective sets of elements are the same, thereby providing the target assembly with a secondary emission characteristic having a peak in the center.

7. In a tube as set forth in claim 1, said beam deflection means including one or more pairs of parallel deflection plates straddling said beam, the plates of each pair being made of electrically resistive material and being each connected in series with a source of potential whereby each plate draws a current to set up a potential gradient along its width and transversely of said beam, and the current flow in the plates of each pair being in opposite directions whereby the centers of said plates will be of the same potential along the straight path of the beam when the latter is undeflected, but whereby when the beam is deflected from said straight path into an area of opposite polarity of said plates the deflection will be amplified by said opposite polarity in a direction at right angles to the original deflection.

8. In a tube as set forth in claim 1, said beam deflection means including one or more pairs of parallel deflection plates straddling said beam, the plates of each pair being made of electrically resistive material and being each connected in series with a source of potential whereby each plate draws a current to set up a potential gradient along its width and transversely of said beam, and the current flow in the plates of each pair being in opposite directions whereby the centers of said plates will be of the same potential along the straight path of the beam when the latter is undeflected, but whereby when the beam is deflected from said straight path into an area of opposite polarity of said plates the deflection will be amplified by said opposite polarity in a direction at right angles to the original deflection, said collection electrodes feeding current into a load resistance, and at least some of the output current being fed through at least one of said resistive plates to shift the working center of the beam on the target to center the beam about a predetermined working point on the target.

9. In a tube as set forth in claim 1, said beam deflecting means including two coils disposed on each side of said beam and parallel thereto, the coils being energized by an input signal for deflection of the beam, and the characteristic impedance of the coils being such that the input signal propagates therealong at the same velocity as the electron beam passing therebetween.

10. In a tube as set forth in claim 1, said beam deflection means including two coils disposed on each side of said beam and parallel thereto, the coils being energized by an input signal for deflection of the beam, and the characteristic impedance of the coils being such that the input signal propagates therealong at the same velocity as the electron beam passing therebetween, said collection electrodes feeding current into a load resistance, and at least some of the output current being fed through said coils to shift the working center of the beam on the target to center the beam about a predetermined working point on the target.

References Cited in the file of this patent

UNITED STATES PATENTS

2,069,441	Headrick	Feb. 2, 1937
2,441,296	Snyder	May 11, 1948
2,475,644	Soller	July 12, 1949
2,481,458	Wertz	Sept. 6, 1949
2,613,273	Kalfaian	Oct. 7, 1952
2,618,762	Snyder	Nov. 18, 1952