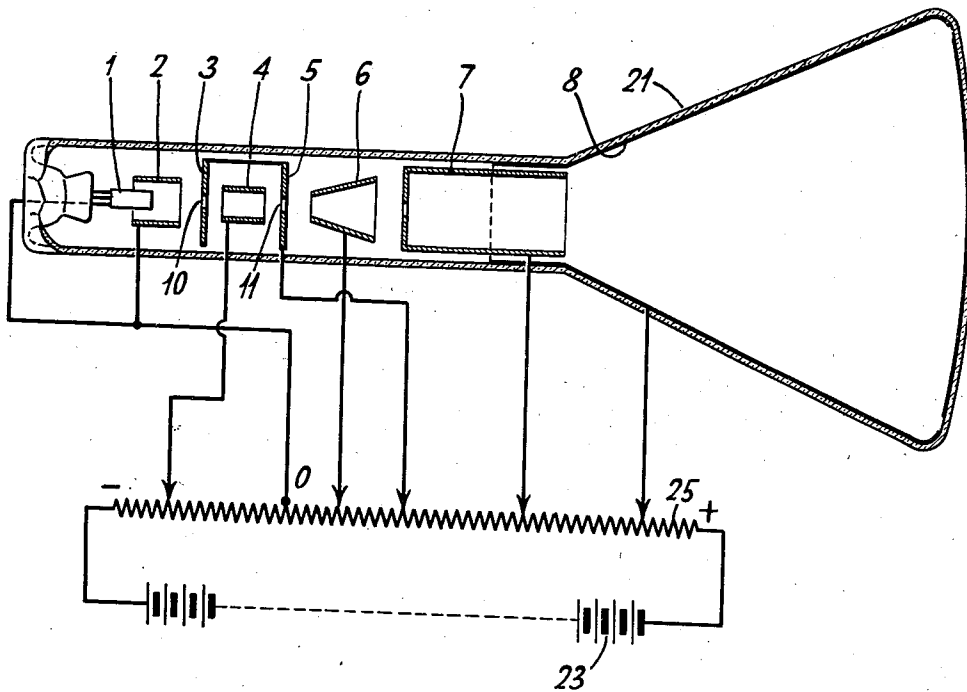


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ELECTRON DEVICE
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INVENTOR
KURT DIELS
BY *H. S. Hoover*
ATTORNEY

UNITED STATES PATENT OFFICE

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ELECTRON DEVICE

Kurt Diels, Berlin-Friedenau, Germany, assignor
to Telefunken Gesellschaft für Drahtlose Tele-
graphie m. b. H., Berlin, Germany, a corpora-
tion of Germany

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This invention relates to electron devices and more particularly to those devices using concentrated beams of electrons and provides both method and means for producing improved focussed beams of electrons by suppressing secondary electronic emission from the electron optical system used to focus the electrons.

In cathode-ray tubes, especially where used for television purposes, secondary electrons are apt to be released by the electron ray pencil upon its passage through the aperture of an electrode, provided that the diameter of the pencil of electrons is equal to, or greater than, the diameter of the electrode aperture. These secondary electrons prove troublesome in the path of the rays for the reason that at the point where they are emitted they possess a velocity of only a few volts as contrasted to the high velocity of the primary electrons, and the result is that, if another electron lens is mounted at some point in the direction of their travel they require a lens of a different focal length than the primary electrons. If the said electronic lens is so set or disposed that the electrons are brought to focus upon the fluorescent or luminescent screen or other imaging or focussing surface the spot of impact will appear blurred or out of focus because of the very fact that the secondary electrons have failed to be concentrated in this spot.

To obviate this disadvantage it has been suggested in the prior art to treat ray-limiting conductor parts—more particularly apertures or stops or diaphragms to be imaged and mounted in the discharge path anteriorly of the electron-optic system to be imaged or focussed, in such a way as to prevent their yielding secondary electrons, and/or to mount in the vicinity of such apertures or diaphragms, that is, at points at close proximity to the ray, stops designed to collect secondary electrons. While it is true that such a device insures the desired purpose, it has certain undesirable properties. For instance, if a secondary-electron collector or shielding electrode of the kind before mentioned is mounted in the neighborhood of the diaphragm to be imaged, the result is that in the opening of the collector diaphragm, between the latter and the next electrode, which has dissimilar potentials, a small lens is produced. This lens moreover is filled as far as the very edge by the cathode ray so that it is liable to introduced imaging distortions in the ray path. Inasmuch as it is imperative that the collector diaphragm should be mounted at close proximity to the focussed pencil without touching the same, while, on the other hand, the

diameter of the ray may be subject to enlargements and constrictions in the course of modulation, the case may moreover arise that the collecting diaphragm, when the aperture of the cathode ray pencil is enlarged, is hit by electrons of the pencil and is thus caused to yield, in turn, secondary electrons. Now, these difficulties are obviated by this invention.

The invention shall be explained in more detail as applied to an exemplified embodiment thereof by reference to the appended drawing. The electrons emitted from the cathode 1, first under the influence of the field set up by the electrodes 1, 2 and 3 are directed towards the opening 10 of the electrode 3, whereupon, by the action of the condensing field set up between the electrodes 3, 4 and 5 they are concentrated in the aperture 11 of the stop 5. Suppose that this latter aperture is the one to be focussed and imaged upon the luminescent screen. The electrons passing through this aperture have a speed which is governed by the potential tapped on the potentiometer shown undesignated. However, in addition secondary electrons are generated in the aperture 11 of the disk electrode 5 which possess substantially lower speed. The next following electrode 6 which, for reasons to be set forth in more detail further below, is funnel-shaped preferably and is kept at a potential which is negative in relation to electrode 5. To be more explicit, 6 in relation to electrode 5 is at least so much more negative that the secondary electrons set up at 5 of low speed will be unable to buck the field resulting between 5 and 6, while the primary electrons of higher speed passing through the opening 11 in the absence of any impedance and obstruction will be capable of doing this. In other words, the action of electrode 6 is that only the primary electrons are utilized for the imaging of aperture 11 upon the luminescent screen. The funnel-shaped construction of the electrode 6 is of advantage in several regards in practice. Owing to the fact that the narrower funnel aperture is located anteriorly of the aperture of the diaphragm to be imaged with the result that the action therethrough of the following electrodes is greatly diminished, it follows that the potential at the electrode 6 need to be but little negative compared with that of the electrode 5 in order to insure the desired retention and arrest of the secondary electrons. Between the shielding or collector electrode 6 and the electrode 7 being at a higher potential, to be sure, lens action may be present. However, since the wide funnel opening is turned towards the electrode 7, there re-

sults a lens which has a large diameter compared with the pencil diameter. Insofar as its section is taken up and occupied by the pencil, the said lens will introduce but slight errors or distortions into the electromagnetic system. The lens inside the range of electrode 6 serves as a pre-focussing lens. The main lens is formed by the field set up between the electrodes 7 and 8. The inside diameter of the funnel-shaped electrode 6 may be so chosen that also changes in aperture caused upon modulation (which, for instance, may be applied to the electrode 4) will cause no contact between the ray and the electrode 6.

In lieu of the funnel electrode 6 it would be possible also to use a sequence or series of electrodes presenting an inside diameter which grows with growth of distance from the diaphragm, the electrode being mounted at greatest proximity to the diaphragm being maintained at negative potential in reference to the diaphragm. The following electrodes along the path of the ray may have impressed upon themselves potentials which become more positive by steps as the distance from the diaphragm increases.

In a practical tube the following potentials were applied in sequence to the rotation symmetric electrodes 1 to 8:

Cathode 1 and cylinder 2	= 0 volts
Stops 3 and 5	= +300
Cylindrical electrode 4	= - 50
Funnel electrode 6	= +250
Electrodes 7 and 8	= +600 and +5000 v., respectively.

A truncated cone or funnel electrode of the kind shown in the drawing proves particularly appropriate. However, instead of such a funnel electrode it is possible also to use an auxiliary electrode of a different form posteriorly of the diaphragm or aperture to be imaged, provided that care is taken so that this electrode is so dimensioned, biased, and mounted that the action produced by positive electrodes mounted after the aperture to be imaged in the direction of the ray through and upon the opening of the diaphragm electrode will be so slight that the secondary electrons there released will be arrested by the auxiliary electrode. If this condition is fulfilled, it will practically be solely those electrons which pass unobstructedly through the diaphragm that are used for electron-optic imaging of the diaphragm so that the imaging of the diaphragm will be invariably adequately sharply focussed.

If in lieu of the funnel electrode a cylinder electrode is employed, then, if the lens set up between it and the next following electrode is to have the same diameter as in the case of using a funnel-shaped electrode, it must have the same inside diameter as the wide aperture of the funnel electrode. However, in order that, for the same potential at the cylinder electrode and at the next following electrodes, the same "through" or penetrating action may be secured as with a funnel electrode, the cylinder electrode must be made correspondingly longer and/or its potential must be chosen more negative. These conditions hold good also in the case where a diaphragm electrode is used which is to have the same diameter as the wide opening of the funnel electrode.

What I claim is:

1. A cathode ray tube comprising a cathode, a concentrating electrode concentric with the cath-

ode, an apertured disk electrode in register with both the concentrating electrode and cathode, followed by in the order named and positioned in register with the disk electrode and spaced longitudinally therefrom and from each other, a cylindrical electrode, a second apertured disk electrode, an apertured imaging annular conical electrode whose minimum internal diameter is larger than the aperture of said second disk electrode, a first anode, and a second anode, means within the tube to maintain the two disk electrodes at the same potential, and a target member positioned in register with all of said electrodes and beyond said second anode.

2. A cathode ray tube comprising a cathode, a concentrating electrode concentric with the cathode, an apertured disk electrode in register with both the concentrating electrode and cathode, followed by in the order named and positioned in register with the disk electrode and spaced longitudinally therefrom and from each other, a cylindrical electrode, a second apertured disk electrode, an annular conical electrode whose minimum internal diameter is larger than the aperture of said second disk electrode, said conical electrode being positioned with its minimum internal diameter adjacent to said second disk electrode, a first anode, and a second anode, means within the tube to maintain the two disk electrodes at the same potential, and a target member positioned in register with all of said electrodes and beyond said second anode.

3. A cathode ray tube comprising an envelope having a conical section and an elongated cylindrical neck affixed to the conical section at the point of minimum diameter, an end wall closing the larger diameter end of said conical section, a cathode supported within the cylindrical neck, a concentrating electrode concentric with said cathode, an apertured disk electrode in register with both the concentrating electrode and cathode, a target surface supported on said end wall, a combination of electrodes in the order named counting from said apertured electrode positioned intermediate said apertured electrode and said target surface, comprising a cylindrical electrode, a second apertured disk electrode, an apertured imaging conical electrode adapted to be maintained negative with respect to said second apertured disk electrode to repel secondary electrons from the apertured disk, a first anode and a second anode, and means within the tube to maintain the two disk electrodes at the same potential.

4. A cathode ray tube comprising a cathode, a concentrating electrode concentric with the cathode, an apertured disk electrode in register with both the concentrating electrode and cathode, followed by, in the order named and positioned in register with the disk electrode and spaced longitudinally therefrom and from each other, a cylindrical electrode, a second apertured disk electrode, an apertured imaging conical electrode adapted to be maintained negative with respect to said second apertured disk electrode to repel secondary electrons from the apertured disk, a first anode, a second anode, means within the tube to maintain the two disk electrodes at the same potential, and a target surface positioned in register with all of said electrodes and beyond said second anode.

KURT DIELS.