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ELECTRON DEVICE

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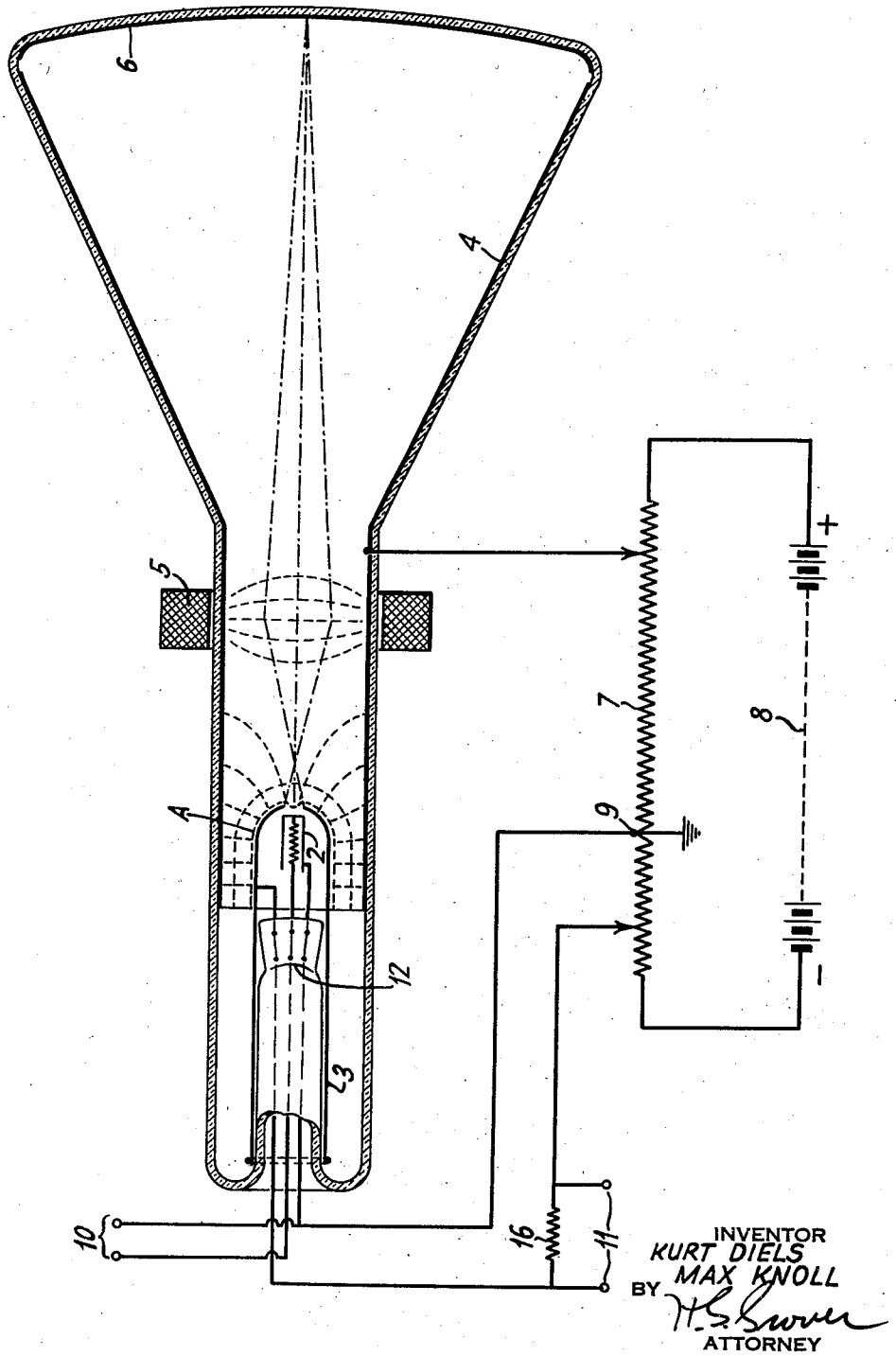

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ELECTRON DEVICE

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The present invention relates to a simple arrangement for producing an extremely small luminous electron spot of high brilliance and sharpness which retains these properties even when the beam undergoes modulation. The arrangement according to the invention is especially well suited for high voltage cathode ray tubes for television purposes. In order to give an idea regarding the quality of the spot attainable with the arrangement described in the following, it is pointed out that this quality is sufficient for the production of very bright images of great detail, for instance, of 600 lines definition and more, and that this quality of the spot is not reduced by modulation of the ray.

The hitherto known and proposed arrangements are incapable of solving this problem and in addition, require a cumbersome electrode assembly. Extensive tube structures were used in the prior art which aside from the cathode required no less than 5 to 10 further electrodes for producing the luminous spot. Where simpler electrode systems such as those of 2 to 3 electrodes were used, the quality of the spot obtained was far from that necessary for a large number of line for high definition for reasons which will be explained below. Hence, it was assumed that large numbers of lines could only be handled by means of a comparatively cumbersome electrode assembly.

A known arrangement requiring a smaller number of electrodes consists for instance of a cathode surrounded by a Wehnelt cylinder, an accelerating diaphragm shaped anode and a reproducing lens for instance, a magnet coil. In this arrangement a small diaphragm shaped opening in the anode is utilized as object being reproduced. Since the electrons have practically reached their end velocity within this opening, the size of the spot appearing on the flouresscent screen is determined primarily by the geometrical proportion existing between the width of the object and the width of the image as well as by the size of the diaphragm opening. Where an extremely large number of lines is desired, therefore, either the aperture of the diaphragm must be very small, or the width of the object is to be chosen very large. If the aperture in the diaphragm is very small, the number of electrons traversing the anode aperture is greatly limited which hinders obtaining a sufficiently bright spot. If on the other hand the width of the object is increased, inconvenient dimensions are obtained for the tube, furthermore, at high operating potentials such as are necessary for instance in the case of projection tubes, flashovers occur easily between the edges of the anode diaphragm and the control electrode, or cathode. In addition, in such an arrangement the secondary emission of the anode diaphragm has a disturbing effect.

The arrangement according to the invention avoids these drawbacks and has with the smallest number of means, the surprising aforementioned degree of efficiency. Accordingly, an important object of our invention is to provide a new and improved cathode ray tube.

Another object of my invention is to provide a much simplified cathode ray tube structure capable of giving increased definition and higher beam currents than obtainable by known structures.

Other objects of our invention will become evident upon consideration of the following explanation taken together with the drawing.

The invention will be described in greater detail in the following in reference to the figure representing an example of the construction of a cathode ray tube embodying the circuit.

The electrons leaving the cathode **2** of the tube **1** are exposed on the one hand to the influence of a negatively biased electrode **3** surrounding the cathode and across which eventually a control of the current is carried out and on the other hand, said electrons are under the influence of a single accelerating anode having a wide aperture and designated by **4**. The latter preferably has the form of a cylinder and rests at the wall of the tube in that it forms for instance a wall layer. It is obvious that the anode may have a cylindrical form only at the beginning and may have the conical enlargement nearer towards the screen. The electrode **3** is preferably shaped in the manner of a sleeve if the tube is to be operated with high potentials, such as, for instance, with 50 kilovolts and more, for reasons which will be explained below, whereby the said sleeve, as seen from the figure surrounds the entire press **12** of the tube and is rounded off towards the screen. At lower operating potentials also a shorter cylinder electrode **3** may be used, which is simply closed up by a flat circular disk having an aperture which is in front of the cathode. For focusing the electrons a magnet coil **5** is used. In the figure, item **6** is a screen, **7** and **8** represent a potentiometer for tapping the required tube potentials and which is grounded at the place designated by **9**. At the terminals **10** the heating voltage is impressed while at the terminals **11** there is applied a modulation potential

if such a potential is eventually to be used. The surprisingly high degree of efficiency of the simple arrangement described results from the following:

The minuteness and the sharpness of the spot on the screen are due to the fact that by means of a preliminary condenser lens of particular properties which is indicated by the equi-potential plane A, a very minute and well-defined crossing point of the electrons is produced which in turn is reproduced on the screen by means of the principal lens and without a diaphragm for limiting the ray. It was believed not possible to produce an electron crossing point of such properties with a single preliminary concentration lens, unless short ray paths are provided for the preliminary concentration in order to assure convenient tube size. As can be seen from numerous arrangements actually known, the opinion prevailed that in the case of a single preliminary concentration lens for the production of a sufficiently minute point of crossing the required diffractive force could be obtained only when utilizing a very considerable curving of the equi-potential surfaces. But such lenses have naturally serious faults resulting in a poor definition of the point of crossing. Therefore, whenever a particular minuteness of the spot on the screen was required, the structure with a single preliminary concentration lens of particular curvature was disregarded and in place thereof arrangements were employed having two or a greater number of lenses of smaller curvature, i, e., with less serious faults. When bearing in mind that for each lens at least two electrodes are necessary which are maintained at different potentials it can be readily seen that the number of electrodes increases.

The invention solves the problem of providing a very minute and well defined point of crossing to be reproduced by the main lens contrary to the existing prejudice regarding a single preliminary concentration lens. As pointed out such a lens must have a high diffractive force and still be devoid of lens faults. The requirements, which appear on the surface to be irreconcilable with each other, are fulfilled in accordance with the invention, in that for the preliminary concentration lens only such a curvature of the equi-potential surface is admitted as will still be allowable in regard to the lens faults, especially the spherical aberration, and that at the same time the lens electrode of the preliminary concentration lens which has the lower potential is followed directly by the electrode which imparts to the electrons the end velocity. This measure is based on the teaching that the diffractive force of an electron lens can, without thereby changing the optical quality, be increased by an increase of the potential difference between the lens electrodes. The electrode system is so constructed that the requirement of a high potential difference between the lens electrodes can be fulfilled without danger to the safety of operation of the tube, i. e. the electrode **3** is rounded out in the manner shown in the drawing; furthermore, sharp edges and grid structures are obviously to be avoided in the tube.

The favorable degree of efficiency of the described arrangement becomes understandable from the following: Owing to the high field intensity, the penetration through the aperture of the electrode **3** is sufficiently high even in the case of a small diameter. Now, a small diameter of the electrode **3** is beneficial gain as regards the minuteness of the point of crossing. If modulation potentials are applied to the electrode **3** for instance across the resistor **16**, then owing to the high field intensity at the lens electrodes substantially no variation in the spot size takes place. Such a condition is due to the following reasons:

In the described system, only a minor part of the cathode has emission owing to the high field intensity. At the control region the field intensity increases rapidly and the cathode receives thereby a very high specific load. The cathode area participating in the emission thereby varies but slightly so that the crossing point changes are substantially nil.

A further reason for the effectiveness of the described arrangement resides in that the ray path is intercepted only by a single diaphragm aperture which is negatively biased. Thus, there is prevented a production of secondary electrons which would be detrimental to the definition of the point of crossing. A further advantage of the described arrangement lies in the fact that the diameter of the single diaphragm need not be chosen from the outset to correspond with practical requirements since the effective admission range of the diaphragm can be controlled as desired simply by regulating the negative biasing potential of said diaphragm.

The mode of construction shown in the figure permits of an operation with plate potentials having almost any desired high value (up to 100,000 volts and more). The higher the plate potential is chosen, the smaller will be the point of crossing being reproduced, in view of the reasons given above and thus also the diameter of the spot on the screen. Hence, by suitable choice of the potentials and distances is it possible to utilize the described, very simple electrode assembly for the production of screens of any desired fineness such as screens of 600 lines at sufficient sharpness of the spot on the tube screen.

Having described our invention, what we claim is:

1. A cathode ray tube comprising an envelope having a luminescent screen supported on an end wall, a combined focusing and control hollow cylindrical electrode positioned in register with said screen and longitudinally displaced therefrom, said control electrode having a apertured convex exterior at the end of the electrode nearest said screen, an electron emitting cathode supported within said control electrode and immediately adjacent the aperture in said convex exterior, and an anode surrounding at least a portion of said combined electrode and extending substantially to said screen.

2. A cathode ray tube comprising an envelope having a luminescent screen supported on an end wall, a combined focusing and control hollow cylindrical electrode positioned in register with said screen and longitudinally displaced therefrom, said control electrode having an apertured convex exterior at the end of the electrode nearest said screen, an electron emitting cathode supported within said control electrode and immediately adjacent the aperture in said convex exterior, an anode surrounding at least a portion of said combined electrode and extending substantially to said screen, and a magnetic focusing coil positioned intermediate said combined electrode and screen.

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