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ELECTRON LENS

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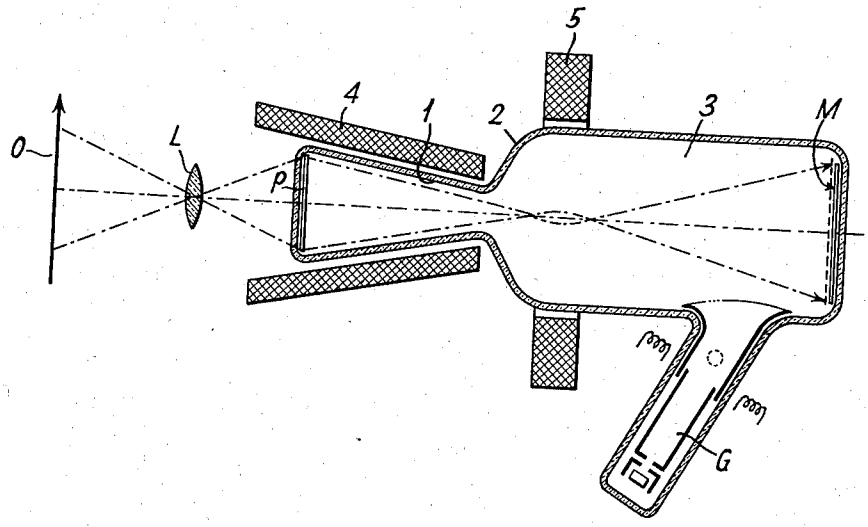

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ELECTRON LENS

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2 Claims. (Cl. 250—153)

The present invention relates to electron discharge devices comprising electron optical systems.

The invention is particularly but not exclusively concerned with the position of lenses for use in electron discharge devices in which an optical image of an object is projected on to a photo-sensitive cathode and the photo-electron image emanating from the cathode being formed by a lens on to a non-photo sensitive mosaic electrode or screen which is arranged to be scanned by a cathode ray beam to produce picture signals, for example, in a television transmission system. An electron discharge device of this kind, termed an "image transmitter," is disclosed in the specification of British Patent No. 442,666.

There are two factors which control the choice of electron lenses used in the above mentioned devices, namely the definition required in the electron image and the distortion produced by the electron lenses. From the point of view of definition and from energy considerations, it is required that the area of the electron image and consequently of the photo-cathode and the mosaic electrode on which the image is focused, should be large, so that the cross sectional area of the cathode ray which is used to scan the mosaic electrode to derive picture signals may be relatively large. On the other hand in the case where the electron image is focused on the mosaic electrode by an electromagnetic coil, the distortion in the electron image increases with the size of the image to an extent depending on the ratio of the coil diameter to the diameter of the electron image. The coil diameter is restricted due to the fact that with a large coil the magnetic field produced would spread too far along the axis of the coil, and would tend to interfere with the scanning beam, and also with some constructions the length of the lens coil used and/or the cross-section of the electron beam may be limited by the geometry of the envelope or tube enclosing the electrodes. Also in the case of an electrostatic lens, if the cross-section of the electron beam is large in comparison with the separation of the plates by which the lens field is produced, a serious amount of spherical aberration will appear in the image obtained.

The object of the present invention is to provide an improved electron optical system which may be used in electron discharge devices to focus a large electron image with small distortion or to produce an electron image in cases where the cross-section of the electron beam is restricted in some parts of its path.

According to the present invention, an electron discharge device is provided comprising a source of electrons from which a beam of electrons is projected along a path, a long frusto-conical electro-magnetic coil with its larger end directed towards said source arranged about said path and adapted to be energized so as to set up a magnetic lens field which causes the cross-section of the electron beam projected from said source to become reduced and the beam to become or tend to become focused, there being a further electron lens constituting device arranged to be energized to set up a further lens field for acting on said electron beam after it has been acted on by the first lens field to produce an electron image.

The method of carrying the invention into practice will be readily understood from the following description in detail, reference being made to the single figure of the drawing which represents diagrammatically an arrangement according to the invention as applied by way of example to an image transmitter of the kind referred to above.

In the arrangement shown in the drawing, P is a large photo-cathode on which the image of an object O is projected by an optical system represented by lens L. This photo-cathode P is arranged on the end of a conical neck portion 1 of the enclosing envelope 2 of a scanning tube, the electron gun of which is shown at G. The neck portion of the tube tapers away from the photo-cathode. In body portion 3 of the envelope is arranged a mosaic electrode M which is adapted to be scanned by a cathode ray, developed by the electron gun G. Surrounding the conical neck portion 1 and extending slightly beyond the photo-cathode P, as shown, is a conical electromagnetic coil 4 which, as described, for example, by Coeterier and Teves in "Physica," vol. 3, 1936, pages 698–976, reduces the cross-section of the electron beam emitted from the photo-cathode P as indicated by the dotted lines in the drawing. Surrounding the body portion 3 of the envelope is a further short electro-magnetic coil 5, by which the electron beam of reduced cross-section is focused on the mosaic electrode M, the focused electron image being of such size as to occupy practically the whole of the available area on the mosaic electrode. With this arrangement the cross-section of the electron beam after the beam has passed through the coil 4 will be small and there will only be a small amount of distortion present, and the image produced by the coil 4 will be found to be both large and free from serious distortion. More-

over, the use of the conical coil 4 as described enables the cross-section of the neck 1 at its point of junction with the body portion 3 to be made relatively small.

While the invention described above is primarily intended for application to image transmitters, it will be appreciated that the invention may also be applied to any arrangement in which an electron image is required to be produced on an extended surface, as for example, in an electron telescope or microscope where no scanning is involved.

If desired, the magnetic coil 5 might be replaced by a suitable arrangement adapted to be charged to different potentials to set up an electrostatic field constituting an electrostatic electron lens rather than an electromagnetic lens as shown in the drawing, in which case also, the arrangement of the invention may be used to lessen the distortion or aberration in the image produced and to overcome difficulties due to the construction of the tube.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:

1. An electron discharge device including a photo-cathode electrode upon which an optical image may be projected and from which an electron current image may be derived, means for directing the photo-electrons constituting the current image along a predetermined path including a long frustro-conical electromagnetic coil arranged about the path with its larger end directed toward said photo-cathode and adapted to be energized so as to set up a magnetic electron lens field which causes the cross-section of the photo-electron beam emitted by said photo-cathode to become materially reduced, means including a further electron lens device adapted to be energized to set up a further magnetic electron lens field for acting on said photo-electron beam, after it has been acted on by the first lens field, to cause divergence of the beam to produce an electron image, and a mosaic electrode upon which the produced electron image may be focused, whereby, because of the reduction in the cross-section of the beam under the action of the field set up in the frustro-conical coil, the distortion arising is less than that which would be produced by said further lens device acting alone.

2. An electron discharge device including a photo-cathode electrode upon which an optical image may be projected and from which an electron current image may be derived, means for directing the photo-electrons constituting the current image along a predetermined path including a long frustro-conical electromagnetic coil arranged concentrically about the path with its larger end directed toward said photo-cathode and adapted to be energized so as to set up a magnetic lens field for causing the cross-sectional area of the photo-electron beam to become materially reduced, means including a second electromagnetic coil adapted to be energized so as to set up a second magnetic lens field for acting on said converged photo-electron beam to cause divergence of the beam to produce an electron image, and an electrode responsive to the electron image upon which the produced electron image may be focused, whereby distortions may be reduced by reason of the convergence and divergence of the electron current image.

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