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ELECTION TUBE MAGNETIC FOCUSING DEVICE

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FIG. 1.

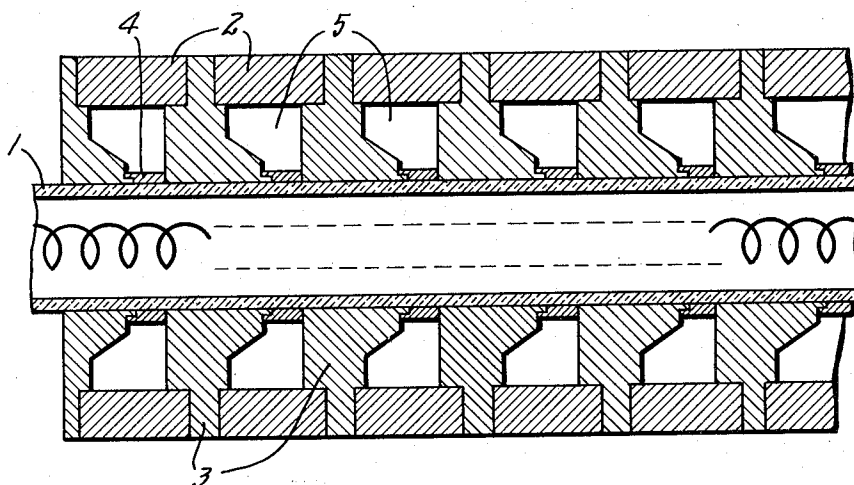
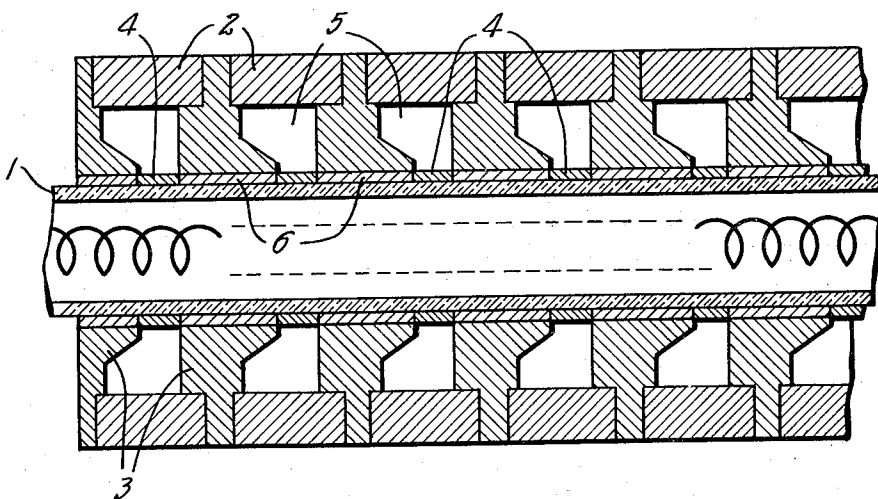


FIG. 2.



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ELECTRON TUBE MAGNETIC FOCUSING DEVICE

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3 Claims. (Cl. 313—84)

This invention relates to the magnetic focusing devices for focusing a long electron beam and more particularly to such devices for use in electron tubes, such as the traveling wave tube.

In electron tubes, such as traveling wave tubes and the like, axial magnetic fields have been used for maintaining the diameter of an electron beam within an approximately fixed value over a long range. In such systems the magnetic field is not necessarily a uniform magnetic field but it is well known that a magnetic field which varies in magnitude somewhat in the manner of a sine wave can be used to produce periodic exact focusing and still maintain the beam within limits of the desired diameter.

In a known form of the magnetic focusing arrangement there are provided a plurality of annular permanent magnets arranged with like poles facing each other and with magnetic yokes extending radially inward of the cylinder formed by these magnets into proximity with the electron beam. It is desirable that the magnetic yoke pieces extend as close as possible to the beam in order to exert the maximum focusing control. However, when they are brought into close proximity with the beam the electro-magnetic wave may excite the cavities existing intermediate the yokes and thus induce unwanted effects which may adversely distort the energy being amplified or the electron beam itself.

In accordance with this invention there is provided a focusing device for a long electron beam such as used in traveling wave tubes, for example, in which series of magnets, either electro-magnets or permanent magnets, are arranged end to end with magnetic yoke pieces extending in the proximity of the beam, the invention being characterized by conductive non-magnetic means interposed between adjacent inner peripheries of the yoke pieces to bridge the gap therebetween and thus to provide a shielding to prevent the electro-magnetic waves from exciting the cavities into resonance.

The above-mentioned and other features and objects of this invention and the manner of attaining them will become more apparent and the invention itself will be best understood by reference to the following description of an embodiment of the invention taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a cross-sectional view of a portion of a magnetic electron beam focusing device incorporating the features of this invention, and

Fig. 2 is a similar sectional view of a further modified form of this invention.

Turning now to Fig. 1, the envelope of a traveling wave tube is shown at 1 having disposed therein the usual helix. The electron beam traverses longitudinal of the envelope 1 within the helix. Externally of the envelope 1 are provided a plurality of magnets 2 shown as permanent magnets. These magnets are arranged so that like poles face each other and intermediate the poles of the magnets are provided yoke members 3 extending radially inwardly of the magnet. The yoke pieces 3 are

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distributed along the axis of the tube so as to form an approximate sine wave curve of the magnetic flux along this axis. Intermediate the inner peripheries of adjacent magnetic yokes 3 are provided rings 4 of non-magnetic material. In the form shown rings 4 have a step projection so as to inter-fit with projections on the yoke pieces. However, it is clear that these may be fastened in place by either means such as brazing or soldering and it is not necessary that such interfitting be provided.

With this type of construction the magnetic yokes may be brought into as close proximity as possible to the electron beam so as to provide the maximum focusing effect. However, because of the continuous conductive cylinder formed by the inner peripheries of the magnetic yokes 3 and the rings 4, the electro-magnetic waves cannot excite the resonant volumes 5 which exist intermediate these yoke members. As a result the magnetic assembly may be positioned as close to the beam as is possible without disturbing the frequency response of the beam because of the resonant cavity effects.

Fig. 2 there is shown a magnetic assembly substantially similar to that shown in Fig. 1. However, in this construction instead of using the inner peripheries of the magnetic yoke assemblies to form the continuous cylinder for shielding from the electro-magnetic effects, there is provided a composite cylinder composed of rings of magnetic material 6 and rings of non-magnetic material 4 forming a substantially continuous cylinder outside the envelope 1 of the tube. The rings of magnetic material 6 are made to extend along the cylinder substantially the same longitudinal length as the inner peripheral surface of the magnetic yokes 3, while the non-magnetic rings 4 substantially bridge the gap that otherwise would exist between these magnetic yokes. Thus there is provided a continuous magnetic focusing system similar to that described in Fig. 1 and having similar advantages. However, in this construction the cylinder and the magnetic yoke assembly may be separately constructed and then assembled so as to be properly positioned as shown.

While the invention has been described in connection with specific embodiments thereof using permanent magnets, it is clear that the principles thereof equally apply to systems using a plurality of individual electro-magnets with the similarly shaped magnetic yokes.

While I have described above the principles of my invention in connection with specific apparatus, it is to be clearly understood that this description is made only by way of example and not as a limitation to the scope of my invention as set forth in the objects thereof and in the accompanying claims.

What is claimed is:

1. A magnetic focusing means for an electron beam tube, having an envelope within which a beam of electrons is projected comprising a plurality of annular magnetic means external of said envelope and positioned in aligned end-to-end spaced relation to provide a cylindrical structure, annular yokes of magnetic material positioned intermediate said magnetic means and extending radially inwardly of said cylinder into proximity with said envelope and spaced apart a predetermined axial length at their inner peripheries to produce magnetic effects in close proximity to the beam, and means for avoiding unwanted resonance effects of the cavities formed intermediate said yokes comprising non-magnetic metallic means intermediate adjacent of said yokes at their inner peripheries, of substantially said predetermined axial length, bridging the gaps between said yokes.

2. A focusing means according to claim 1, further comprising a tube having an envelope enclosing said beam, and wherein the inner peripheries of said yokes are substantially contiguous with said envelope, and

said non-magnetic means comprise rings of metal inter-fitted between the inner ends of said yokes.

3. A focusing means according to claim 1, further comprising a composite cylinder of rings of magnetic and non-magnetic material having an outside diameter substantially equal to the inner diameter of said yokes, said rings of magnetic material having substantially the same axial dimensions as the inner peripheries of said yokes, and positioned to substantially coincide therewith, said rings of non-magnetic material forming said non-magnetic metallic means.

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