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MAGNETRON TUBES AND MAGNET MEANS THEREFOR

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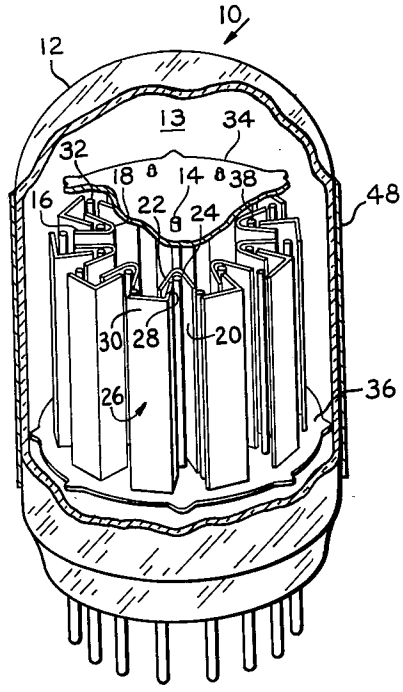

Fig. 1

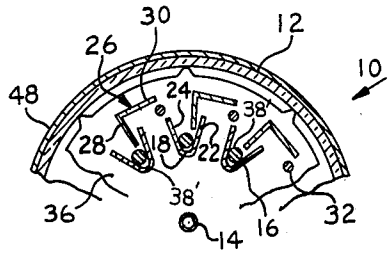

Fig. 2

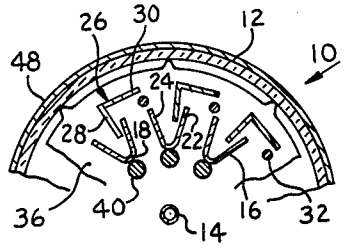

Fig. 3

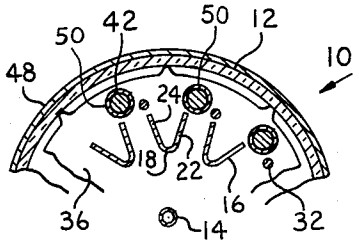

Fig. 4

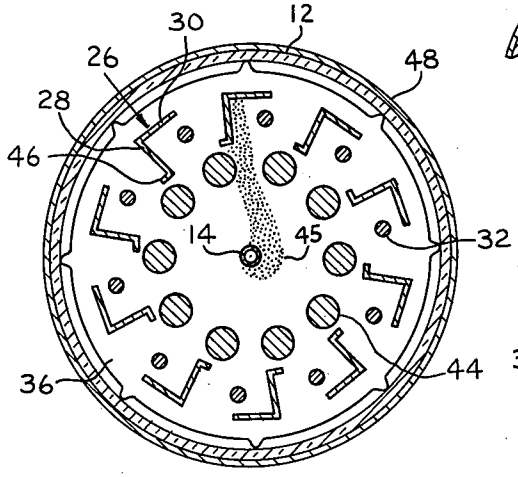

Fig. 5

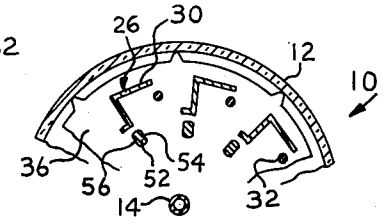

Fig. 6

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MAGNETRON TUBES AND MAGNET MEANS THEREFOR

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This invention relates to magnetron-type electron discharge tubes and to improvements in the construction of such tubes, particularly in the portion thereof which provides the required magnetic field.

One form of magnetron tube, to which the principles of the invention apply, includes an electrode assembly which comprises an elongated central cathode and a plurality of groups of elongated electrodes surrounding the cathode and secured together at their opposite ends by means of insulating end disks or plates. All of the electrodes are substantially parallel to each other. An external cylindrical magnet surrounds the tube envelope and electrode assembly and provides a longitudinal magnetic field within the tube.

While these beam switching tubes are quite satisfactory, they have features which, under some circumstances, may be considered drawbacks. For example, by some standards, the tubes are undesirably large and heavy; and the problem of size and weight is further complicated when the tubes are provided with magnetic shields. In addition, the mounting of the external magnet on the tube is a comparatively critical operation which is also further complicated when a shield is employed.

Accordingly, the principles and objects of the present invention are concerned with the provision of an improved and miniaturized magnetron tube having improved means for providing a magnetic field.

In brief, a magnetron-type electron tube embodying the invention includes, in a suitable envelope, an electrode assembly including a central longitudinally elongated cathode electrode surrounded by groups of longitudinally elongated electrodes which are adapted to form and receive an electron beam from the cathode. The desired longitudinal magnetic field in the envelope, which combines with the electric field therein to control the flow of electrons from the cathode to the various groups of electrodes, is provided by magnetic means mounted within the electrode assembly. This magnetic means may take many forms and may be magnet rods disposed within the electrode assembly, or selected ones of the tube electrodes may be of permanently magnetized material so that the electrodes themselves provide the required magnetic field. Efficient shielding may be achieved, if desired, by means of a simple, thin sheet of magnetic material surrounding the magnet and electrode assembly.

The invention is described in greater detail by reference to the drawing, wherein:

FIG. 1 is a perspective view, partly in section, of a magnetron beam switching tube embodying the invention;

FIG. 2 is a sectional view of a portion of a modification of the tube of FIG. 1;

FIG. 3 is a sectional view of a portion of a modification of the tube of FIG. 1;

FIG. 4 is a sectional view of a portion of still another modification of the tube of the invention;

FIG. 5 is a sectional view of another modification of the invention; and

FIG. 6 is a sectional view of a portion of another modification of the invention.

The principles of the invention are applicable to magnetron tubes and, particularly, to type 6700 magnetron beam switching tubes. This type of tube is shown in FIG. 1 as tube **10** and includes an envelope **12** which contains

an electrode assembly **13** comprising a central longitudinally elongated cathode **14** and ten groups of electrodes spaced radially equidistantly from the cathode and surrounding the cathode. All of the electrodes are substantially parallel to each other and to the cathode.

Each group of electrodes includes a generally U-shaped elongated spade electrode **16** which is closest to the cathode and which includes a trough or base **18** which faces the cathode and an open portion **20**, between its sides **22** and **24**, which faces away from the cathode. Each group of electrodes also includes a generally L-shaped target electrode **26** which is most remote from the cathode and has a first radial wall **28** which lies within the open portion **20** of the associated spade electrode. The target includes a second wall **30** which extends from the first wall to close to the next adjacent spade and thus occupies the space between two adjacent spades. Each spade electrode serves to form and hold an electron beam on its associated target electrode. A generally rod-like switching electrode **32** is also included in each group of electrodes and is positioned between the free end of the wall **30** of each target electrode **26** and the adjacent spade electrode **16**. The switching electrodes are known as switching grids. The electrodes of the assembly **13** are secured together by means of suitable top and bottom insulating end disks **34** and **36** of mica or the like as is well known in the art.

The tube **10** also includes magnet means, to be described, to provide a longitudinal magnetic field in the tube which operates with electric fields therein to provide the desired electron beam flow. According to the invention, referring to FIG. 1, the magnet means comprises a plurality of permanent magnet rods **38** positioned inside the electrode assembly **13**. One rod is provided for each group of electrodes and is positioned within the trough **18** formed by the arms **22** and **24** of each spade electrode. The rods **38** are about the same length as the other electrodes, and they may be insulated from the spades, if desired. However, in the preferred arrangement (FIG. 2) magnet rods **38'** are in contact with the spades. This arrangement permits the largest magnets to be used whereby the optimum magnetic field is obtained. The rods are held in position in any suitable manner, for example, by means of the insulating end disks, just as the electrodes are. The corresponding north and south magnetic poles of the rods are oriented adjacent to one another to provide the desired direction of rotation of the electron beam. In the tube **10**, the magnet rods are preferably oriented to cause an electron beam to move in a clockwise direction from one group of electrodes or beam position to the next. If desired, the electrodes and the magnet rods may be oriented for counter-clockwise rotation of an electron beam. An electron beam position which is ahead of the beam at any instant is known as a leading position, and a beam position which is behind the beam is known as a lagging position.

The tube **10** may be modified as shown in FIG. 3 in which only a portion of the electrode assembly embodying the modification is shown. In FIG. 3, the magnetic means comprises magnet rods **40** positioned between the base **18** of a spade electrode and the cathode **14**. The rods **40** may be somewhat larger in diameter than the rods **38**, if space allows. The magnet rods **40** may be insulated from the spades, or they may be in contact with the spades **16** as shown in FIG. 3.

In another modification of the tube **10**, the magnet rods may also replace various ones of the tube electrodes. For example, in the portion of the tube **10** shown in FIG. 4, the target electrodes **26** are omitted and magnet rods **42** are provided in their places positioned between adjacent spade electrodes **16**. The rods **42** have a sufficiently

large diameter so that they occupy most of the space between adjacent spade electrodes.

In another arrangement, wherein magnet rods replace tube electrodes, as shown in FIG. 5, magnet rods 44 replace the spade electrodes 16. In addition, the target electrodes 26 are modified by the provision of a narrow wall extension 46 at the inner end of the radial wall 28 of each target electrode. The wall extension 46 aids current collection and extends from the wall 28 in a direction opposite to that of the wall 30 toward the adjacent lagging position and substantially parallel to a small portion of the periphery of the adjacent magnet rod 44. Each magnet rod 44 is adjacent to a wall extension 46, and the bulk of its body lies on the lagging side of the wall 28 remote from the wall 30 so that an unobstructed current flow path is provided from the cathode to each target. Thus, a beam of current 45 follows the path shown, with a portion thereof striking the periphery of the magnet rod 44.

Occasionally, the magnet rods used in the various modifications of the invention may not be uniform along their lengths, and such non-uniformity might adversely affect tube operation. One solution to this problem comprises providing a coating or sleeve of magnetic material, such as soft iron, on the magnet rods. A coating or sleeve 50 of magnetic material is shown on the magnet rods 42 in FIG. 4. It is understood, of course, that such sleeves may be used in any of the modifications of the invention.

In practicing the invention, particularly in the embodiments thereof wherein magnet rods are used as spade electrodes as in FIG. 5 or in conjunction with spades as in FIG. 3, a modified magnet rod is used. This modified magnet rod construction is shown in FIG. 6 as employed in an electrode assembly of the type shown in FIG. 5. In FIG. 6, each magnet rod 52, which also serves as a spade electrode, has its wall formed to provide substantially flat opposed wall portions 54 and 56 which face the leading and lagging positions, respectively. With this type of construction, a wider spacing between magnets and a wider current flow path are provided, and tube operation appears to be improved thereby. The opposed faces 54 and 56 may also be tapered to provide generally wedge-shaped magnet rods.

In still another modification of the invention, the basic electrode assembly 13 of the type 6700 tube is employed and this includes all of the elements of FIG. 1 except the magnet rods 38. In this case, the desired magnetic field is provided by making either the targets 26, spades 16, or switching grids 32 of permanent magnet material. If desired, magnet rods may also be included in this type of construction.

The magnetron tube constructions described herein are particularly advantageous in that they may be shielded more simply and efficiently than similar tubes having an external cylindrical magnet. A suitable shield for any of the tubes described above may comprise a thin, lightweight sheet of magnetic material 48, preferably having low reluctance and high permeability. Such a sheet is wrapped around the envelope as shown in FIG. 1 and secured in position by any suitable fastening means such as a chemical adhesive, a mechanical clamp, or the like. If desired, the glass portion of the envelope may be omitted, and the shield may comprise the tube envelope itself.

From the foregoing description of the principles of the invention, it will be clear to those skilled in the art that modifications may be made in the mechanical configurations described. For example, the magnet rods may be of any suitable size and they may be positioned in any suitable location permitted by the overall tube construction.

What is claimed is:

1. A magnetron beam switching tube including an envelope; an electrode assembly in said envelope; said electrode assembly having a longitudinal axis and including a cathode and a plurality of groups of electrodes; each group including a target electrode which receives an electron beam and produces an output signal therefrom, a spade electrode which holds an electron beam on its associated target electrode, and a switching electrode which serves to switch an electron beam from one group of electrodes to the next; and permanent magnet means mounted within said electrode assembly and providing a longitudinal magnetic field therein.

2. The tube defined in claim 1 wherein said permanent magnet means comprises a plurality of permanent magnet rods.

3. The tube defined in claim 1 wherein each spade electrode is generally U-shaped and includes a pair of side walls and a base portion connected between said side walls, and said permanent magnet means comprises a permanent magnet rod mounted between the side walls of each spade electrode.

4. The tube defined in claim 1 wherein said permanent magnet means comprises a plurality of permanent magnet rods positioned between each spade electrode and said cathode.

5. The tube defined in claim 1 wherein said permanent magnet means comprises a plurality of permanent magnet rods positioned between each spade electrode and said cathode and in contact with each spade electrode.

6. A magnetron beam switching tube including an envelope; an electrode assembly in said envelope; said electrode assembly having a longitudinal axis and including a cathode and a plurality of groups of electrodes; each group including a target electrode which receives an electron beam and produces an output signal therefrom, a spade electrode which holds an electron beam on its associated target electrode, and a switching electrode which serves to switch an electron beam from one group of electrodes to the next; said spade electrodes comprising permanent magnets.

7. The tube defined in claim 6 and including auxiliary magnetic permeable material within said electrode assembly in operative relation with said permanent magnets for providing a more uniform longitudinal magnetic field in said electrode assembly.

8. The tube defined in claim 7 wherein said spade electrodes comprise permanent magnet rods.

9. A magnetron beam switching tube including an envelope; an electrode assembly in said envelope; said electrode assembly having a longitudinal axis and including a cathode and a plurality of groups of electrodes; each group including a target electrode which receives an electron beam and produces an output signal therefrom, a spade electrode which holds an electron beam on its associated target electrode, and a switching electrode which serves to switch an electron beam from one group of electrodes to the next; said target electrodes comprising permanent magnets.

10. The tube defined in claim 9 wherein said target electrodes comprise permanent magnet rods positioned between adjacent spade electrodes.

11. The tube defined in claim 9 and including auxiliary magnetic permeable material within said electrode assembly in operative relation with said permanent magnets for providing a more uniform longitudinal magnetic field in said electrode assembly.

12. A magnetron beam switching tube including an envelope; an electrode assembly in said envelope; said electrode assembly including a cathode and a plurality of groups of electrodes; each group including a target electrode which receives an electron beam and produces an output signal therefrom, a spade electrode which holds an electron beam on its associated target electrode, and a switching electrode which serves to switch an electron beam from one group of electrodes to the next; at least one of said electrodes in each group comprising a rod-shaped magnet, said tube thus including a plurality of

rod-shaped magnets providing a longitudinal magnetic field in said tube, said magnets being oriented surrounding said cathode, said magnets having a generally circular cross-section except for a pair of flattened opposed wall portions.

13. The tube defined in claim 12 wherein said rod magnets comprise said spade electrodes and said flattened wall portions face, one in the leading direction and one in the lagging direction in said tube.

14. A magnetron beam switching tube including an envelope; an electrode assembly in said envelope; said electrode assembly including a cathode and a plurality of groups of electrodes; each group including a target electrode which receives an electron beam and produces an output signal therefrom, a spade electrode which holds an electron beam on its associated target electrode, and a switching electrode which serves to switch an electron beam from one group of electrodes to the next; permanent magnet rods mounted within said electrode assembly and providing a longitudinal magnetic field therein, and a sleeve of magnetic material on each of said magnet rods to render said rods magnetically uniform.

15. A magnetron beam switching tube including an envelope, an electrode assembly in said envelope including a cathode electrode for producing an electron beam and a plurality of groups of electrodes to each of which

an electron beam can flow under the influence of crossed electric and magnetic fields, said electrode assembly having a longitudinal axis and utilizing a longitudinal magnetic field for controlling electron flow, and permanent magnet means providing a longitudinal magnetic field within said electrode assembly, said permanent magnet means being mounted within said electrode assembly in intimate and operative relation with said groups of electrodes.

16. The tube defined in claim 15 wherein said permanent magnet means comprises a plurality of permanent magnet rods mounted within said electrode assembly parallel to the longitudinal axis thereof.

17. The tube defined in claim 15 wherein said permanent magnet means comprises a plurality of permanent magnet rods with one rod being provided in association with each group of electrodes and operable both as a magnet and as a tube electrode.

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