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MAGNETRON TUBES

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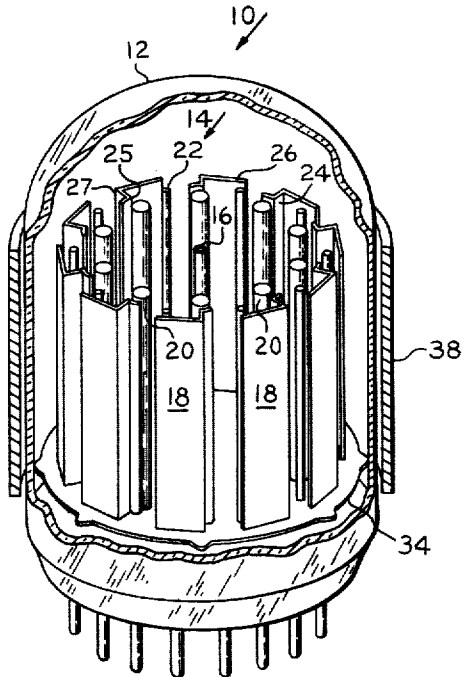

Fig. 1

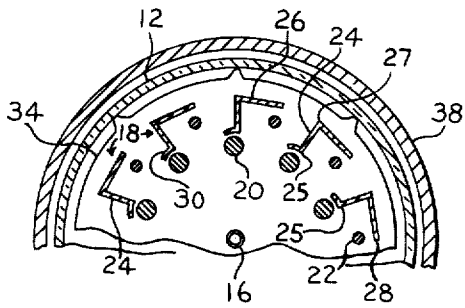

Fig. 2

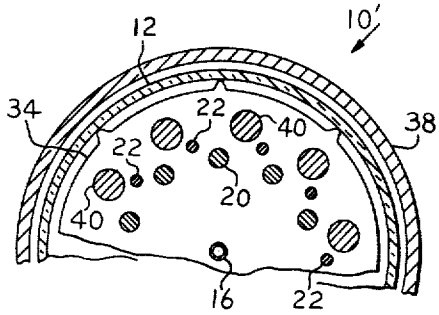

Fig. 3

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MAGNETRON TUBES

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This invention relates to magnetron-type electron discharge tubes and to improvements in the construction of such tubes.

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 in the electrode assembly.

In operation of this type of tube, a beam of current flows from the central cathode and is urged to rotate around the tube under the influence of crossed electric and magnetic fields. The beam may remain at one group of electrodes indefinitely, or it may be switched from position to position by the application of proper potentials to selected ones of the tube electrodes.

The operating efficiency of these tubes depends on many factors including electrode spacings, the strength and rigidity of the electrode assembly, magnet strength and position, and the like. Although satisfactory commercial magnetron beam tubes are now available, improvements may always be made which simplify manufacturing processes and which lead to improvement in tube efficiency and the tube operation in general.

Accordingly, the principles and objects of the present invention are concerned with the provision of an improved magnetron beam switching tube having a construction which lends itself to improvements in manufacturing efficiency and to improvements in tube operation efficiency.

In brief, a magnetron tube embodying the invention includes an electrode assembly comprising 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. Each group of electrodes comprises a position to which an electron beam may flow. Each group of electrodes includes an output or target electrode which receives an electron beam and provides an output signal therefrom, a spade electrode which serves to form and hold an electron beam on its associated target electrode, and a switching electrode which serves to switch an electron beam from position to position.

In the past, the spade electrodes have been generally U-shaped electrodes and each spade electrode was intimately related with a target electrode which was generally L-shaped. According to the invention, each spade electrode has a circular cross-section and each target is shaped to provide the proper operation with a spade so shaped. In a modification of the invention, all of the tube electrodes have a circular cross-section.

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 groups of electrodes, is provided either by a cylindrical permanent magnet surrounding the tube envelope or by equivalent magnet means inside or outside the envelope.

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

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

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

FIG. 3 is a sectional view of a portion of a tube embodying a modification of the invention.

The principles of the invention are applicable to magnetron beam switching tubes such as type 6700 tubes. This type of tube is shown in FIG. 1 as tube **10** and includes, briefly, an envelope **12** which contains an electrode assembly **14** comprising a central longitudinally elongated cathode **16** and ten groups of electrodes spaced radially equidistantly from the cathode and surrounding the cathode. The electrodes are all substantially parallel to each other and to the cathode.

Each group of electrodes represents a position at which an electron beam may be formed and from which a corresponding output signal may be transmitted. An electron beam may be switched from position to position under the influence of crossed electric and magnetic fields within the electrode assembly. The direction in which an electron beam tends to switch is determined by the orientation of these fields and may be clockwise or counterclockwise. The electrode configuration shown is used with clockwise movement of an electron beam. This configuration would be reversed for counterclockwise movement. A position which is ahead of an electron beam at any instant is known as a leading position and its electrodes are leading electrodes; and a position which is behind the beam is known as a lagging position and its electrodes are lagging electrodes.

Each group of electrodes in the tube **10** includes an output or target electrode **18**, a spade electrode **20**, and a switching electrode **22**, each of which performs the function described above. According to the invention, the spade electrodes **20** have a circular cross-section and comprise elongated hollow or solid cylinders. The spade electrodes are oriented on a circle having the center of the cathode **16** as its center. The target electrodes **18** similarly oriented surrounding the cathode and more remote from the cathode than the spade electrodes. Each target electrode is generally L-shaped and includes a first radial wall **24** which extends toward, and is substantially aligned with, the leading portion of the periphery of its corresponding spade cylinder **20**. The inner end **25** of the radial wall **24** extends close to the spade cylinder but is suitably spaced therefrom.

Each target **18** also includes a first lateral wall **26** which is substantially perpendicular to the radial wall **24** and extends in a leading direction from the outer end **27** thereof so that it occupies the aperture or current flow path between adjacent spade cylinders. The target also includes a second lateral wall **30** which extends in a lagging direction from the inner end **25** of the radial wall. The second lateral wall is curved, lies parallel to the wall of the spade electrode, and substantially follows the contour of the spade cylinder. The second wall is comparatively short and extends along only a small portion of the circumference of the spade cylinder. The second wall serves to block possible current leakage paths which might exist if the wall were not present and is made sufficiently long to perform this function.

Each switching electrode **22** comprises a generally cylindrical rod which is positioned, effectively, between the leading end **28** of the first lateral wall **26** of each target electrode **18** and the adjacent leading spade electrode **20**. The switching electrodes are shown as switching grids. The electrodes of the assembly **14** are secured together in any suitable fashion, for example by means of suitable top and bottom insulating end disks, only the bottom one of which **34** is shown.

The desired longitudinal magnetic field for the tube **10** may be obtained by any suitable means, for example, a cylindrical permanent magnet **38** surrounding the tube

envelope **12** and secured with respect thereto in any suitable fashion.

In a modification of the invention shown in FIG. 3, tube **10'** includes all of the elements of tube **10** except that the targets **40** in tube **10'** comprise hollow or solid cylinders. The target cylinders **40** are of sufficient size and are positioned so that they substantially fill the current flow space between the corresponding spade and switching electrodes **20** and **22**, respectively.

One advantage of the present invention relates to the mechanical construction of the tube **10**. Since the spade electrodes are circular in cross-section, rather than U-shaped or shaped in some other way, a stronger and more rugged electrode assembly may be provided. This results from the fact that circular or rod-like electrodes are most readily secured in an electrode assembly of the type described. Automatic assembly is also more feasible with circular electrodes. The construction of tube **10'** is thus particularly advantageous. In addition, electrodes having a circular cross-section are more easily inserted in mica support plates without damaging the plates.

With respect to tube operation, the present invention provides a magnetron beam switching tube which functions efficiently over a wide range of tube operating voltages. In addition, the characteristic curve relating spade current and spade voltage has its peak at a more positive voltage than in prior art tubes. This indicates that greater beam control and greater tube operating efficiency are achieved.

What is claimed is:

1. In a magnetron beam switching tube, an 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; said spade electrode and said switching electrode being generally rod-like in form, said target electrode being generally L-shaped and including a first portion which extends across the space between adjacent groups of electrodes, a second portion which lies between said first portion and said spade electrode, and a third portion which is arcuate in form and has a curvature which matches that of its spade electrode, said third portion lying close to the surface of the adjacent spade electrode so that leakage electrons may be collected thereby, said third portion extending in a lagging direction from said second portion, and means providing a longitudinal magnetic field in said tube.

2. The tube defined in claim 1 wherein each spade electrode is positioned between the cathode and its associated target electrode, the target electrode including a radial wall which extends toward its spade electrode and an auxiliary wall which extends from said radial wall spaced from and substantially parallel to the surface of the spade electrode, each target electrode including a lateral wall extending toward the next leading target electrode and lying across a substantial portion of the width of the current flow space between adjacent spade electrodes, said switching electrode being positioned between said lateral wall and the next leading spade electrode.

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