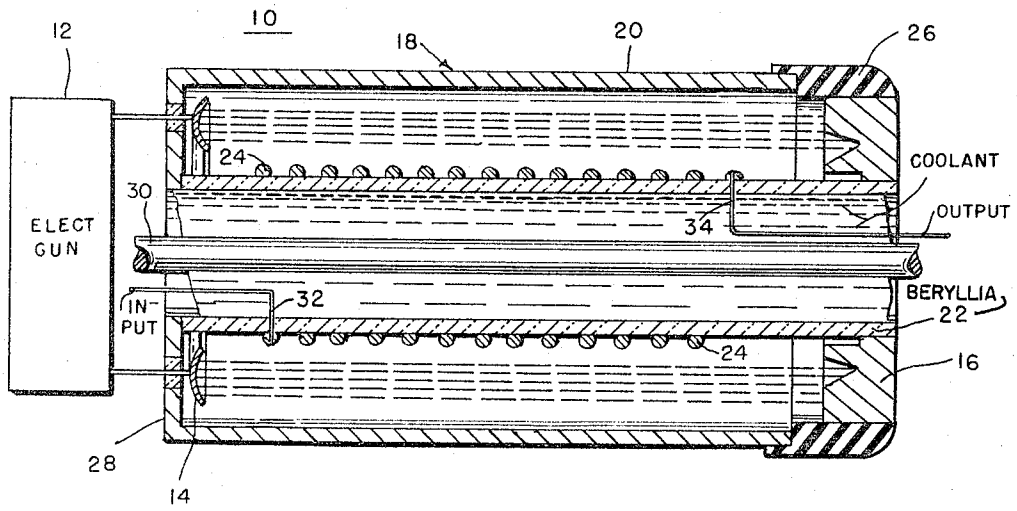
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MODIFIER TRAVELING WAVE TUBE

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MODIFIED TRAVELING WAVE TUBE

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ABSTRACT OF THE DISCLOSURE

A traveling wave tube including a transmission circuit which comprises an evacuated annular cylinder having an outer metallic surface and an inner surface made of beryllia upon which is deposited a slow-wave propagating structure. An annular electron beam passes through the evacuated cylinder and interacts with the electromagnetic wave propagated along the slow-wave circuit, and a liquid coolant is passed through the center of the beryllia cylinder and in contact with the beryllia surface. To provide an axial magnetic field, a permanent magnet is axially aligned within the cylinder.

This invention relates to traveling wave tubes and more particularly to traveling wave tubes utilizing pre-formed or printed wave propagating structures.

Traveling wave tubes generally consist of a slow-wave propagating structure through or along which an electron beam is directed so that an interaction between this electron beam and a component of the electromagnetic wave on the structure may occur. Conventionally, such wave propagating structures usually consist of a helix supported by rods or wedges. Recently, however, it has been found that such helical structures could be produced by means of a photo deposition process wherein the slow-wave helical structure is deposited on a cylinder made of beryllia or other suitable ceramic material. For efficient operation, the inside of the ceramic cylinder was evacuated to provide a high vacuum. Although helical wave propagating structures made in accordance with the photo deposition process were found to have greater stability and linearity than conventional helical propagating structures and could also be produced cheaply in large quantities with the same uniform characteristics, certain limitations and disadvantages were inherent in such structures. For example, a helical propagating structure made by the deposition process usually required a non-propagating helix within the ceramic cylinder to provide a leakage path therefrom for any electric charges resulting from the passage of the electron beam within and in close proximity to the ceramic cylinder. The requirement of such a non-propagating helix complicates the construction of the traveling wave tube and also increases the cost thereof. Also, the presence of the ceramic cylinder concentrates fields through the ceramic or very close to it, thereby making it difficult to exchange energy between the electron beam and the photo deposited helical structure. The concentration of such fields becomes greater at higher frequencies thus setting upper limits where efficiency degenerates very heavily and losses in the ceramic becomes too great.

It is an object of the present invention to provide a traveling wave tube wherein the above limitations are overcome.

It is another object of the present invention to provide an improved traveling wave tube adapted to operate at relatively high frequencies with high interaction efficiency.

In accordance with the present invention, there is provided a traveling wave tube which includes a transmission circuit comprising an evacuated annular cylinder having

an outer metallic surface and an inner ceramic surface. The ceramic surface has deposited thereon a helical slow wave propagating structure or any other suitable slow-wave structure. Included further is an annular electron beam which passes through the evacuated annular cylinder and interacts with the electromagnetic wave propagated along the helix.

For a better understanding of the invention, together with other and further objects thereof, reference is had to the following description taken in connection with the accompanying drawing which illustrates an embodiment of my invention.

Referring now to the drawing, there is shown at **10** a traveling wave tube having at one end thereof an electron gun **12** which serves as the source of an annular cylindrical electron beam. The electron gun **12** is of a design well known in the art and the electron emissive annular cathode is shown at **14**. At the opposite end of the tube **10** there is provided a collector electrode **16** which is in target relation with the cathode **14** to collect the spent electrons. The axially aligned propagating wave structure comprises an annular cylinder **18** having an outer metallic cylindrical surface **20** and an inner cylindrical surface **22** made of a suitable ceramic such as beryllia which contains the helical slow wave structure **24** or any other well known slow-wave circuit. As hereinabove mentioned, the helical slow-wave structure **24** is deposited on the ceramic surface by means of a photo deposition process well known in the art. The annular cylinder **18** is terminated at one end by the collector electrode **16** which is hermetically sealed to both the inner and outer surfaces of annular cylinder **18**. The other end of the annular cylinder **18** is terminated by an annular metallic cover **28** which is also hermetically sealed to both the outer and inner surfaces of annular cylinder **18**. The annular cylinder **18** is evacuated to provide a high vacuum. As shown, the annular beam derived from cathode **14** is passed through the evacuated annular space of cylinder **18** to the collector target electrode **16**. A permanent magnet as at **30**, may be centrally positioned along the axis of the cylinder **18** to provide the necessary magnetic field to focus the annular electron beam as it passes through the evacuated annular space of the cylinder **18**. It is to be understood of course that the permanent magnet **30** is shaped to provide a uniform field. If desired, an external magnetic field surrounding the outer metallic surface **20** may be provided in the conventional manner. Cooling of the helix **24** is accomplished by passing water or other suitable cooling liquid through the center of the cylinder **18** so that the cooling liquid is in contact with the beryllia surface **22**. Suitable coupling leads, as at **32** and **34** are brazed to the ends of the deposited helical structure **24** to provide input and output electromagnetic wave coupling leads into and out of the deposited helical structure **24**.

In operation, the electromagnetic wave energy is propagated along the helical structure **24** by any suitable means well known in the art. The required velocity of the annular electron beam may be controlled by suitable D.C. potentials which have been eliminated for purposes of clarity. The hollow beam generated at the cathode interacts with the longitudinal fields between adjacent turns of the helical structure **24** and the spent beam is collected by the target electrode **16**.

While there has been described what is at present considered to be the preferred embodiment of this invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and it is therefore aimed in the appended claim to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. In a traveling wave tube utilizing a wave transmission circuit for propagating electromagnetic waves in field coupling relation with an electron stream, the combination including a transmission circuit comprising an evacuated annular cylinder having an outer metallic surface and an inner surface comprised of beryllia, said beryllia surface having deposited thereon a helical slow-wave structure, an annular electron beam passing through said evacuated cylinder and interacting with the electromagnetic wave propagated along said helix, a liquid coolant passing through the center of said cylinder and in contact with said beryllia surface, and a permanent magnet axially aligned within said cylinder for providing a magnetic field for focusing said annular electron beam.

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