HERMETIC WINDOW CONSTRUCTION OF WAVEGUIDE FOR EXTREMELY HIGH FREQUENCY ELECTRONIC TUBES

Yoshio Kato, Minoo-shi, and Osamu Konou, Kyoto, Japan, assignors to Matsushita Electronics Corporation, Osaka, Japan, a corporation of Japan
Filed July 8, 1964, Ser. No. 381,107
Claims priority, application Japan, July 12, 1963.
30/38,278
5 Claims. (Cl. 333—98)

This invention relates to hermetic window construction of waveguide for extremely high frequency electronic tubes, for use in input and output portions of radio wave of the electronic tubes.

The primary object of the present invention is to provide a relatively simple hermetic window construction of a waveguide, in which the dielectric and metallic parts can be hermetically sealed together in an easy manner, and yet reflection and loss of radio wave are made extremely little even in millimeter wave region.

There are other objects and particularities of the present invention, which will be made obvious from the following detailed description, with reference to the accompanying drawings, in which:

FIGS. 1 and 2 are perspective views in longitudinal sections of two examples of conventional hermetic waveguide constructions of waveguides:

FIG. 3a is a perspective view in longitudinal section of a hermetic window construction embodying the present invention;

FIG. 3b is a cross-sectional view taken at line A—A' in FIG. 3a;

FIGS. 4 and 5 are graphs showing performances of the embodiment of the invention as shown in FIG. 3.

Conventional hermetic window constructions of circular resonance type for super high frequency band are shown in FIGS. 1 and 2, for example. In the construction shown in FIG. 1, a couple of choke flanges are used in combination, while in the construction shown in FIG. 2, a dielectric disk 1 is sealed within a cylindrical waveguide. In millimeter wave region, however, the parts should be of extremely minute dimensions. For example, the dielectric disk 1 should be 0.1 mm. in thickness and about 2 mm. in diameter in 4-mm. wave length region. As a result, in a complicated construction as shown in FIG. 1, dimensional precision is very difficult to obtain, and even in a construction as shown in FIG. 2, the dielectric disk 1 becomes so thin that the area of its contact with metallic part is not sufficient to assure positive hermetic sealing therewith.

According to the present invention, such a difficult problem is never encountered even in an extremely high frequency region.

Referring now to FIG. 3, a rectangular waveguide 3 is provided with a short cylindrical flange or enclosure 5 forming therein a thin cylindrical space 4 of diameter D₀ and thickness W, the thickness W being thin in comparison to the diameter D₀. The enclosure 5 is made of metal such as iron-nickel-cobalt alloy, titanium, copper, or the like, and in its outer end face 11 is formed an annular angular cut 7 of cylindrical configuration, in which a dielectric disk 6 of diameter D₁ and thickness t of glass, ceramics, sapphire, quartz, or the like is placed in a position perpendicular to the axis of waveguide 3, and is positively sealed to the enclosure 5 between the annular edge portion of the disk plane and the annular shoulder presented by the annular angular cut 7, by means of glass-sealing, brazing, or other suitable means depending upon the nature of material. In axial contact with the enclosure 5, another metallic enclosure 9 having therein a cylindrical space 10 of the same dimensions with the space 4, and belonging to another rectangular waveguide 8, is provided and fixed to the enclosure 5 in axial alignment. A hermetic waveguide window is thus formed in a simple manner.

With the above construction, the dielectric disk 6 can be sealed to the enclosure 5 in a positive manner along the annular edge portion of the disk plane having radial width of \( \frac{1}{2} (D₁-D₀) \). The sealing may also be effected along the peripheral face having width t of the disk 6. There might occur disturbance of electromagnetic field by virtue of the existence of annular angular cut 7 of radial width \( \frac{1}{2} (D₁-D₀) \), but it has been found that such a disturbance can be adjusted by adoption of appropriate dimensional relations between the diameter D₀ and thickness W of cylindrical spaces 4 and 10, and others, to obtain good transmission characteristics over a wide frequency band.

Thus, according to the present invention, if the specific permittivity of disk 6 is \( \epsilon \), and the respective lateral widths of rectangular waveguides 3 and 8 are \( a \), the dimensions are determined to have the following relations:

\[
0.15a < \epsilon x t < 0.5a \\
0.7a < D₀ < 1.0a \\
0.05a < W < 0.25a \\
0.1a < (D₁-D₀) < 0.3a
\]

With such dimensional relations, it has been found that the electric field component of transmitted electromagnetic wave is mainly so distributed as to be perpendicular to the plane of the dielectric disk 6, and the voltage standing wave ratio (VSWR) and the transmission loss are sufficiently decreased over the whole region of frequency band employed in rectangular waveguides 3 and 8.

According to the present invention, the glass-sealing or brazing of dielectric disk 6 may be effected between the annular edge portion of the plane of disk 6 and the annular shoulder presented by the annular angular cut 7, which is perpendicular to the axis of waveguide, and moreover, a length

\[
\frac{D₁-D₀}{2} + t
\]

of sealing region may exist between gaseous areas at both sides of the portions to be sealed together, so that positive and superior hermetic sealing may be obtained.

The above-described hermetic window construction was tested in a frequency range from 8.2 to 12.4 gigacycles, and the results are shown in FIGS. 4 and 5. The hermetic window construction under experiments had the following dimensions:

\[
a = 22.9 \text{ millimeters}, D₀ = 0.96a, D₁ - D₀ = 0.175a, W = 0.196a, \epsilon x t = 0.32a
\]

The dielectric disk 6 was made of borosilicate glass of 1.5 millimeters thickness with \( \epsilon = 5 \), which glass can be sealed with iron-nickel-cobalt alloy of the enclosure 5. As seen from FIGS. 4 and 5, the voltage standing wave ratio is lower than 1.14, and the transmission loss is lower than 0.4 decibel. Such extremely superior characteristics can be obtained in any band of further higher frequency, as is readily understood from the law of similarity of electro-magnetic wave.

The present invention is featured, as is obvious from the embodiment hereinabove described, by the facts that a dielectric disk of glass, ceramics, sapphire, quartz, or the like is hermetically sealed in an annular angular cut formed around the open end of a thin cylindrical space at the abutting faces of a pair of metallic enclosures, in a position perpendicular to the axis of rectangular wave-
3,281,729

3,281,729 3 guides, thus providing positive sealing area for the thin dielectric disk, and yet providing hermetic waveguide with little reflection and loss of radio wave, and that the manufacture of a miniature waveguide having hermetic window for millimeter wave electronic tube is facilitated. The new hermetic window construction is applicable to traveling wave tubes, as well as backward wave tubes, particularly of millimeter waves. In addition, it is to be understood that the present invention is also applicable to hermetic windows for gas sealing, in general.

What is claimed is:

1. A hermetic window construction for a waveguide for an extremely high frequency electronic tube comprising first and second rectangular wave guides having connecting portions on the ends thereof, said connecting portions being joined in abutting relationship to define a thin cylindrical space therein and therebetween, an annular angular cut being formed in the abutting face of at least one said connecting portion, a dielectric disk being placed in said annular angular cut perpendicular to the axis of said rectangular wave guides, said disk being sealed to said annular angular cut along at least the annular edge portion of the plane of said dielectric disk, the thickness t and specific permittivity ε of the window, the lateral width a of said rectangular wave guides, the diameter D₀ and thickness W of said cylindrical space in the one part of said enclosure, and the diameter D₁ of the annular angular cut being selected in the following relations:

\[0.15a < \epsilon t < 0.5a\]
\[0.7a < D₀ < 1.0a\]
\[0.05a < W < 0.25a\]
\[0.3a < (D₁ - D₀) < 0.3a\]

2. A hermetic window construction according to claim 1 in which said dielectric disk is additionally sealed to said enclosure along the peripheral face of said disk.

3. A hermetic window construction according to claim 1 in which said dielectric disk is made of a material selected from a group consisting of glass, ceramics, sapphire, and quartz, while said enclosure is made of a metal selected from the group consisting of an iron-nickel-cobalt alloy, titanium, and copper.

4. The hermetic window construction according to claim 1, in which said dielectric disk is additionally sealed to said enclosure along the peripheral face of said disk.

5. The hermetic window construction according to claim 1, in which said dielectric disk is made of a material selected from a group consisting of glass, ceramics, sapphire, and quartz, while said enclosure is made of a metal selected from the group consisting of iron-nickel-cobalt alloy, titanium and copper.

References Cited by the Examiner

UNITED STATES PATENTS

2,483,768 10/1949 Hershberger .............. 333—98
3,100,881 8/1963 Edson ..................... 333—98

HERMAN KARL SAALBACH, Primary Examiner.

L. ALLAHUT, Assistant Examiner.