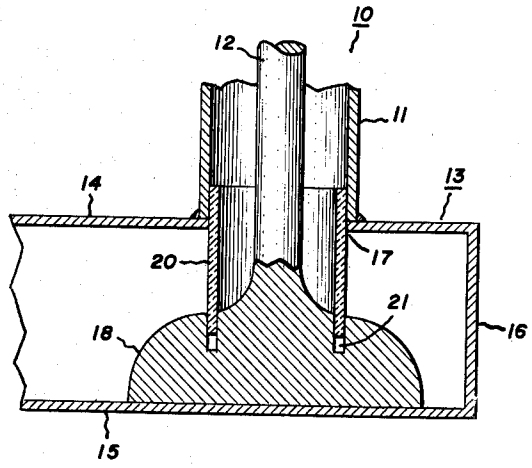
April 16, 1963 J. N. LIND 3,086,181

COAXIAL LINE TO WAVEGUIDE TRANSITION

Filed May 6, 1960



INVENTOR:
JAMES M. LIND,
BY Urban H. Faubion
HIS ATTORNEY.

United States Patent Office 3,086,181
Patented Apr. 16, 1963

3,086,181
COAXIAL LINE TO WAVEGUIDE TRANSITION

James N. Lind, Lexington, Mass., assignor to General Electric Company, a corporation of New York

Filed May 6, 1960, Ser. No. 27,299
3 Claims. (Cl. 333—34)

This invention relates to transmission line transition units for coupling a coaxial transmission line to a rectangular waveguide. More particularly the invention relates to such a transition which incorporates a barrier or window to separate two regions in a waveguide or waveguide system and provides for the transmission of electromagnetic waves between the two regions.

In designing waveguide systems, the designer recognizes that transmission of microwave power through the system at the level at which the waveguide fails due to voltage arc-over normally is not possible because of other elements in the microwave waveguide system. In other words, other elements in the system do not have the power handling capability of the waveguide. For example, transitions of the type under consideration are wont to break down at a lower power level than the waveguide due to the presence of high electric and magnetic fields in the transition. Another problem encountered when using a transition in waveguide systems is the introduction of reflections at the transition.

The problems encountered in providing a transition from coaxial lines to waveguides and various solutions to the problem are discused in greater detail in "Microwave Transmission Circuits" by G. L. Ragan, volume 9 of the MIT Radiation Laboratory Series, 1948, pp. 314 to 361, "Transition from Coaxial Lines to Waveguides" by F. L. Nieman. Specific reference is made to the discussion of the "doorknob" type transitions found on pp. 349 through 353 inclusive. As is pointed out in the Ragan reference one of the best solutions to the problems encountered in providing coaxial line to wave guide transitions is the transition known in the art as the "doorknob" type. The reference also points out that the reflection problems are reduced to a minimum by the use of this transition and that the limitations on the use of this type of transition have been failure of the coaxial line by voltage breakdown.

An object of the present invention is to ameliorate the voltage breakdown problem in the "doorknob" type transition.

An example of an application in which the transition provided is of particular use is found at the input and output waveguide connections of an electronic tube which operates at microwave frequencies. In such applications electromagnetic energy must be transmitted between the evacuated interior of the tube envelope and waveguide systems which may be maintained at atmospheric pressures. Other applications where the particular transition is of use is found in systems where a barrier is required to prevent the escape of gas from a pressurized system or where a barrier is required to contain a cooling or insulating fluid in a waveguiding system. In other words, the transition is provided with a barrier so that the coaxial line and the waveguide systems which are joined by the transition may be maintained at different pressures or contain different media.

In carrying out the present invention a "doorknob" type transition between coaxial line and waveguide is provided with a barrier whereby the coaxial line (the part of the system most likely to fail by voltage arc-over) may be maintained under vacuum or other pressure to reduce possibility of voltage breakdown.

The novel features which are believed to be characteristic of the invention are set forth in the appended claims. The invention itself however, both as to its organization and method of operation together with further objects and advantages thereof may best be understood by reference to the following description taken in connection with the accompanying drawing in which the only FIGURE is a central, vertical, longitudinal section taken through a coaxial line to wave guide transition illustrating the present invention.

The single FIGURE of the drawing shows a coaxial line to waveguide transition embodying the present invention. From an inspection of the FIGURE it is seen that a coaxial transmission line **10** is joined to a waveguide **13** of rectangular cross section. The coaxial transmission line **10** includes an outer conductor **11** having the configuration of a hollow right circular cylinder and a solid inner conductor **12** of circular cross section concentrically disposed within the outer conductor **11**. The rectangular waveguide **13** has walls composed of a conductive material. The upper and lower walls **14** and **15** respectively of the rectangular waveguide are the broad walls. One end of the rectangular waveguide **13** is closed by a rectangular conductive end wall **16** while the other end remains open so that electromagnetic waves may pass into or out of the waveguide **13**.

In order to join the coaxial transmission line **10** to the waveguide **13** a circular aperture **17** is provided in the upper broad wall **14** of the waveguide. As illustrated, the aperture has a diameter that exactly corresponds to the internal diameter of the outer conductor **11** of the coaxial transmission line. Thus, the outer conductor **11** of the coaxial transmission line is positioned with one end around the aperture **17** and joined thereto as by brazing to form a joint which is mechanically sound and preferably vacuum tight. In order to achieve the transition the center conductor **12** of the coaxial transmission line **10** extends on beyond the end of the outer conductor **11** across the waveguide **13** and is terminated on the opposite side of the guide in a conductive knob **18** which has a shape similar to a doorknob. The shape of the terminal knob **18** gives the transition its name. The terminal knob **18** may also be considered to have the appearance of an inverted wine glass with the stem of the wine glass forming the center conductor **12** of the coaxial transmission line and the upper part of the wine glass being flush against the lower broad wall **15** of the waveguide. The terminal knob **18** (doorknob) may be considered an inverted stub in a cross coaxial line and waveguide transition. The purpose of the stub is to match the susceptance as measured in the coaxial line which excites the waveguide or is excited by electromagnetic energy in the waveguide.

The transition described up to this point is a doorknob transition of the type discussed in the Ragan reference supra. It is felt that a discussion of the design parameters necessary to obtain the desired matching is not in order here since the design of such a transition is adequately described in the Ragan reference.

As previously indicated the limit on the peak power handling capability of the "doorknob" transition is the peak power handling capability of the coaxial transmission line **10**. In order to increase the power handling capability of the coaxial transmission line the transition is constructed in such a manner as to allow the coaxial transmission line to be evacuated hence greatly increasing the dielectric strength within the line. In order to accomplish this a cylindrical dielectric microwave window **20** is interposed in the transition in such a manner as to form a vacuum tight seal between the coaxial transmission line **10** and the waveguide **13**. A typical window material is a commercially available high alumina ceramic or glass.

As illustrated the cylindrical window has approximately the same external diameter as the internal diameter of the outer conductor **11** of coaxial transmission line **10**.

In addition, the doorknob terminal **18** of the transition is provided with a relatively deep groove **21** which extends concentrically around the center conductor **12** and has a diameter corresponding to that of the window **20** and a width which corresponds to the thickness of the window **20**. In order to seal the opposite ends of the cylindrical window to the elements of the transition the outer surface is metallized around both ends and its inner surface is metallized at its lower end. The lower end of the cylindrical window **20** is inserted in the groove **21** provided in the knob **18** and the upper end of the window **20** protrudes up into the outer conductor **11** of the coaxial transmission line **10**. The opposite ends of the window are then sealed in vacuum tight relation to the coaxial transmission line and the doorknob terminal **18**. As illustrated, the groove **21** in which the lower portion of the window **20** is seated is made deeper than is necessary to hold the window in order to provide an additional inductance or inductive cut to obtain better matching.

While a particular embodiment of the invention has been shown it will, of course, be understood that the invention is not limited thereto since many modifications in the arrangement may be made. For example, the increased power handling capability of the transition results from making the transition in such a way that the dielectric inside the coaxial transmission line **10** may be increased. Thus, it is apparent that the coaxial transmission line **10** may be either pressurized or evacuated. Further, it is apparent that the diameter of the window **20** may be increased by changing the configuration only slightly so that the coaxial window sits wholly within the waveguide **13**. In this manner the dielectric losses in the window are decreased since increasing its diameter positions the dielectric window **20** in regions of weaker electric fields. It is also apparent that cooling may easily be achieved by making the center conductor **12** of the coaxial transmission line **10** hollow and circulating a cooling fluid through it. It is contemplated that the appended claims will cover this modification and other modifications as fall within the true spirit and scope of this invention.

What I claim is new and desire to secure by Letters Patent of the United States is:

1. A transition for coupling waveguide systems including a coaxial transmission line segment for connection to one waveguide system; a rectangular waveguide segment for connection to a second waveguide system, said waveguide segment comprising at least two oppositely disposed walls; a comductive knob-like member; and a barrier providing a vacuum tight seal between said segments; said rectangular waveguide segment being provided with an aperture through one of said walls; said coaxial transmission line segment comprising an outer conductor and an inner conductor having a portion thereof extending beyond the end of said outer conductor; said outer conductor being positioned with said end adjacent said one wall in such a manner that said end terminates at said one wall and said inner conductor portion extends through the aperture; said knob-like member having the base thereof conductively affixed to the other of said walls in a position opposite to said aperture and having the upper portion thereof conductively joined to said inner conductor portion, said knob-like member being larger in diameter than said aperture; said knob-like member having an annular groove extending therearound and in concentric relationship with said inner conductor portion; said barrier comprising a cylindrical dielectric member open at both ends thereof and

having one end positioned and sealed in the annular groove and the opposite end extending at least to said one wall and sealed thereto.

2. In a transition assembly which provides a vacuum tight barrier between two waveguide systems and permits transmission of electromagnetic waves between the systems, a first hollow conductive waveguide means having a rectangular cross section defining at least two oppositely disposed walls and provided with an aperture in one of said walls, a second conductive waveguide means which includes a coaxial transmission line having an inner and an outer conductor, said inner conductor having a portion thereof extending beyond the end of said outer conductor, a conductive knob-like member larger in diameter than said aperture and having the base thereof conductively affixed to the other of said walls in a position opposite to said aperture, and a hollow cylindrical dielectric barrier open at both ends thereof, said second conductive waveguide means positioned adjacent the aperture in said one wall of said first conductive waveguide means in such a manner that said outer conductor conductively engages said one wall and said inner conductor portion extends across the interior of said first waveguide means and is conductively joined to the upper portion of said knob-like member, said knob-like member having an annular groove therearound concentric with said inner conductor portion, said hollow cylindrical barrier being positioned with one end in said annular groove and sealed thereto and the opposite end extending at least to the said one wall of said first waveguide means and sealed thereto.

3. In combination in a transition assembly for coupling waveguide systems and providing a vacuum tight barrier between the systems, a hollow waveguide member of rectangular cross section provided with an aperture in one wall a coaxial transmission line having a hollow outer conductor and an inner conductor, said inner conductor having a portion thereof extending beyond the end of said outer conductor, a knob-like conductive terminal larger in diameter than said aperture and having the base thereof conductively affixed to the wall of said waveguide member opposite to said one wall, and a hollow cylindrical dielectric barrier open at both ends thereof, said coaxial transmission line being positioned adjacent said waveguide member in such a manner that said outer conductor conductively engages said one wall and surrounds the aperture therein and said inner conductor portion extends through the aperture across the interior of said waveguide member and is conductively joined to the upper portion of said knob-like terminal, said cylindrical barrier being positioned within said waveguide member concentrically around said inner conductor portion in such a manner as to form a vacuum tight barrier between said transmission line and said waveguide member.

References Cited in the file of this patent

UNITED STATES PATENTS

2,434,508	Okress et al.	Jan. 13, 1948
2,530,171	Okress	Nov. 14, 1950
2,922,127	Dench	Jan. 19, 1960

FOREIGN PATENTS

1,068,324	Germany	Nov. 5, 1959

OTHER REFERENCES

Ragan: Microwave Transmission Circuits, vol. 9, Rad. Lab. Series, 1948, page 341.