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J. F. KANE

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TRANSMISSION LINE WINDOWS

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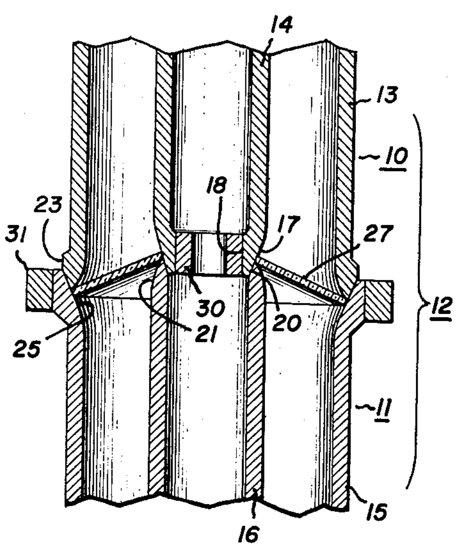
FIG.1.



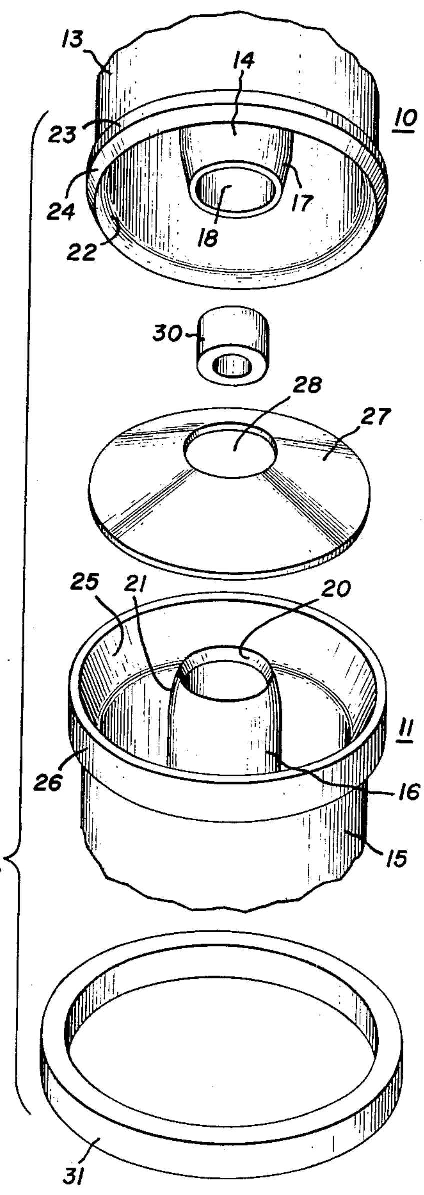


FIG.2.

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TRANSMISSION LINE WINDOWS

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This invention relates to barriers for pressurized or evacuated waveguides and the supporting structure for such barriers. That is, the invention relates to window barrier sections which separate two regions in a waveguide or waveguide system and provide for the transmission of electromagnetic waves between the two regions. In particular the barriers or seals of the type under consideration are useful in conjunction with waveguide of the type generally referred to as coaxial, i.e., waveguide which has one conductor disposed within another in a coaxial relationship.

An example of waveguide windows or barriers of the type under consideration is found in the input and output waveguide connections of an electron 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 pressure. Other examples of such windows are found in applications 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 waveguide system. These barriers, which are called microwave windows, have taken various forms using a variety of metals and dielectric materials.

The use of microwave windows introduces a number of electrical problems which would not otherwise be present. The electrical problems include the introduction of reflections at the dielectric barrier due to the discontinuity in the medium in which the electromagnetic waves must travel, voltage breakdown in the presence of high electric magnetic fields in the area of the dielectric barrier and the dissipation of microwave power within the dielectric material. The mechanical problems encountered include difficulty in providing a leakproof mechanical design which can withstand the elevated temperatures required for processing and operation (may be as high as 600° C.), has the mechanical strength to maintain line dimensions at correct values and is capable of reproduction in quantity with uniformity in dimensions and properties.

The electrical problems involved may best be understood by considering a particular application for microwave windows of the type under consideration. As an example consider a window for the transmission of microwave energy from a high power source such as a klystron to an external waveguide system. An output window for such generators should be capable of transmitting the generated power to the waveguide system with a minimum of reflection and absorption of energy. Power absorbed at the window or reflected by the window is lost and reflected energy may severely damage the power source. Power absorption in a window of a given geometry is a function of properties of the dielectric material and may be determined by selecting the material. Reflections in a transmission line are caused by discontinuities along the length of the line which represent abrupt discontinuities in impedance. Such discontinuities may becaused by a dielectric positioned in the transmission line or it may be caused by a change in the physical dimensions of the transmission line or both.

In the application under consideration the problem of change in physical dimensions of the transmission line does not necessarily occur. However, the problem of matching the impedance at the window or barrier so that the barrier itself does not represent an abrupt reflective discontinuity is one which must be dealt with.

The impedance matching problem is generally not difficult for a particular frequency or a limited frequency range but many of the generators in use are designed to operate over a wide range of frequencies and it is difficult to obtain an impedance match which is effective over the desired frequency range. For example, a typical problem is to obtain an impedance match between waveguide systems which operate over a frequency range of 1500 megacycles per second centered around a frequency such as 2500 megacycles per second, that is, over a frequency range of 1750 megacycles per second to 3250 megacycles per second.

Accordingly it is an object of the present invention to provide a coaxial transmission line window and support structure having a physical configuration which tends to cancel the capacitive impedance effect introduced by the dielectric barrier and produces a minimum of reflection over a wide frequence range.

If an arc over or voltage breakdown occurs in the area of the window the problems with respect to impedance mismatches result but the situation is a great deal more acute. That is to say that if the design of the transmission line barrier is such as to allow a voltage breakdown some power may be transmitted through the barrier but most of the incident power is consumed in the discharge and reflected. Further, if a breakdown occurs in the area of the barrier, the barrier is likely to be ruptured. It is well to note the problem of voltage breakdown may be dependent upon the mechanical design of the window and its supporting structure. Sharp corners or metal projections in the space occupied by electromagnetic fields cause high local electrical field gradients which severely limit the amount of radio frequency voltage which can be applied to the transmission line in the area of the barrier. Brazed joints exposed to the electric field may also cause voltage breakdown problems.

Accordingly it is an object of the present invention to provide a microwave window of the character described which does not include sharp metallic corners, metal projections or brazed joints exposed to electric fields within the transmission line.

Although the mechanical problems involved in microwave windows are easier to understand than the electrical problems they are no less important. For example, if the design of the window and its associated support is not such as to permit a strong vacuum tight joint the barrier is ineffective. Also if the mechanical strength at the window is not sufficient to maintain dimensions both under normal operating conditions and at the elevated temperatures required for processing, the advantages of a careful design are lost. Further, unless the design is capable of production and reproduction in quantity with uniformity in dimensions and properties the usefulness is reduced considerably. The window of the present invention is particularly effective in mechanical design in that it does provide a barrier which separates two regions in the transmission line, presents a simple strong vacuum tight mechanical structure and produces a minimum of reflections over a wide band of frequences.

Briefly stated in accordance with one aspect of this invention a microwave window and support joint is formed between coaxial transmission lines which may be operated at different pressures by introducing a cone of dielectric material between the inner and outer conductors in such a manner that it is directed toward the high pressure line and the joint is formed between inner conductors and outer conductors of the two transmission lines in such a way that no sharp corners exist, brazes may be formed outside of the region of conduction, reinforcement may be provided inside the inner conductor and outside the outer conductor and the mating surfaces of the conductors are forced together by the pressure differential on opposite sides of the barrier.

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 other objects and advantages may best be understood by reference to the following description taken in connection with the accompanying drawing in which:

FIGURE 1 is a central, vertical, longitudinal section through a window and its supporting structure constructed using the principles of the present invention; and

FIGURE 2 is an enlarged exploded view in perspective of the microwave window illustrated in FIGURE 1.

Referring specifically to the figures, two coaxial transmission lines **10** and **11** are joined together at a portion which is generally designated as a transition and window section **12**. For simplicity the systems joined by the transmission lines **10** and **11** and transition **12** are not illustrated. As illustrated both the upper transmission line **10** and the lower transmission line **11** are of approximately the same size and are coaxially disposed end to end. The upper coaxial transmission line **10** consists of an outer cylindrical or tubular conductor **13** and an inner conductor **14** which is also of tubular construction. The inner conductor **14** is coaxially disposed with respect to the outer tubular conductor **13**. The lower coaxial transmission line **11** is illustrated as having an outer tubular conductor **15** which has approximately the same inner and outer diameter as the outer tubular conductor **13** of the upper coaxial transmission line **10** and an inner tubular conductor **16** having substantially the same inner and outer diameters as the inner tubular conductor **14** of the upper coaxial transmission line **10**.

In one application of the transition and window section **12**, one of the transmission lines is evacuated (transmission line **11**) whereas the other system (line **10**) is maintained at atmospheric pressure. The relative pressure of the two coaxial transmission lines is not germane to the invention just as the systems joined are not germane to the particular invention. However, the window described and illustrated is particularly suitable for use with systems wherein a differential pressure is maintained by the window or barrier section **12**.

In order to join the two transmission lines **10** and **11** and provide a continuous conductive waveguide, the ends of the respective inner and outer conductors of the two guides are provided with mating surfaces which are uniquely shaped to provide desirable electrical and mechanical characteristics. For example, consider first the two inner tubular conductors **14** and **16** of the two transmission lines. The inner conductor **14** of the upper transmission line **10** has a short section at its lower end turned in as by spinning to form a somewhat conical surface or nose portion **17** which slopes inwardly toward the center of the conductor. Turning the nose portion **17** down in this manner forces some of the conductive material on the inside of the tubular conductor to form a shoulder **18** around the inner periphery. The particular way in which the surface is formed is not crucial since obviously the tapered nose section **17** could be turned down by grinding or any other means. However, it is desirable to have as much strength in the joint as possible and the shoulder **18** helps in order to provide a mating surface for the nose portion **17** on the end of the tubular inner conductor **16**. A mating land **20** is reamed out inside the inner conductor **16** of the lower coaxial transmission line **11**. The mating land **20** is formed so that it has a slope which corresponds to the slope of the nose section **17**. Thus, when the lower end of the inner conductor **14** is inserted in the interior of the inner conductor **16** of the lower transmission line, a snug fit results. In order to achieve the desired electrical and mechanical characteristics in the joint the outer periphery

of the mating end of the inner conductor **16** of the lower transmission line **11** is also turned down to form a nose portion **21** having sides which slope inwardly. The angle of slope of the sides of nose portion **21** is preferably such that they intercept the nose section **17** on the mating inner conductor **14** at an angle which when the two conductors are joined approaches a right angle.

It should be noted that the voltage gradients which exist everywhere in a coaxial transmission line are greatest near the center conductor, therefore, voltage breakdown is most likely to occur in this region. Consequently the turned down nose portions **17** and **21** on the outer peripheries of the two inner conductors **14** and **16** respectively are shaped in such a way as to present graceful curvature with no sharp corners. Further, the two inner conductors **14** and **16** are brazed together between the mating surfaces **17** and **20** on the two conductors so that the braze is not exposed to the high electric fields.

In order to provide the outer conductors **13** and **15** respectively of the two transmission lines **10** and **11** with a connecting joint, mating surfaces are also formed on them. That is, the interior of the lower end of the upper outer conductor **13** is turned out as by spinning to form a graceful curvature **22** on the inside and produce a land **23** on the outside. A portion of the material turned out to produce the land **23** is removed to form a conical surface **24** that extends around the outer periphery of the end of outer conductor **13** and slopes inwardly toward the center of the conductor. The conical surface **24** is the male mating surface of the joint ultimately formed with the outer conductor **15** of the lower transmission line **11**. A sloping female mating land **25** which slopes at the same angle as the male land **24** on the upper conductor **13** is turned out around the inner periphery of the outer conductor **15** of the lower transmission line **11** in order to provide for a tight mechanical joint. In the process of turning out the female mating land **25** on the lower conductor **15** a land **26** is formed around the outer periphery. The outer conductors **13** and **15** of the two transmission lines are joined by inserting the conical shaped male mating land **24** of the upper conductor **13** into the correspondingly conical shaped female land **25** inside the lower conductor **15** and forming a braze. Thus, the joining braze is not exposed to electric fields inside the conductors **13** and **15** and therefore does not interfere with electrical properties of the transmission lines. Further, in forming the mating land **25** on the inner periphery of conductor **15** and in turning out the interior of the upper outer conductor **13** no sharp corners are formed. That is, the shaping of the metal parts is done in such a manner that a smooth curvature is obtained. Thus, electrical problems which would be introduced by sharp corners are avoided.

The vacuum tight barrier between the two transmission lines **10** and **11** is provided by a ceramic dielectric microwave window **27** which has a frusto-conical configuration. That is, the window **27** has the shape of a truncated cone. As illustrated the window or barrier member **27** is of uniform thickness and has a centrally located aperture **28** formed by the truncation. The base diameter of the conical window **27** is of such a size that it fits snugly within the female mating land **25** on the interior of the lower outer conductor **15** at its intersection with the inner or lower end of the outer conductor **13** when it is positioned with its male mating land **24** within the outer conductor **15**. The aperture **28** formed in the conical window has a diameter which fits snugly around the male conical nose **17** on the inner conductor **14** of the upper conductor **10** at its intersection with the upper end of the inner conductor **16** when the two inner conductors are mated.

An inspection of FIGURE 1 shows that when the components thus far described are mated in the manner described an indentation is formed around the inner periphery of the outer conductors **13** and **15** of the two transmission lines and an indentation is formed around the outer periphery of the inner conductors **14** and **16** of the two transmission lines. These indented portions occur in the area where the microwave window or barrier **27** is positioned. The indented portions introduce inductive impedance in the transmission line which tends to cancel the capacitance introduced by the dielectric ceramic window material. The slope of the sides of the indentures is selected to provide the optimum effect thus, the window arrangement inherently passes a wide range of frequencies without reflections.

The outer periphery of the base of the microwave window **27** is brazed to the two outer conductors at the same time the two outer conductors **13** and **15** are brazed together. In like manner the inner periphery of the truncated cone is brazed to the two inner conductors **14** and **16** at the same time that they are brazed together. The conical ceramic shape of the window **27** ideally points toward the pressurized side of the vacuum seal. In other words if one of the transmission lines **10** or **11** is to be evacuated and the other operated at atmospheric pressure the upper transmission line **10** should be the one which is at atmospheric pressure so that the conical shape points toward the pressurized side of the vacuum seal. Even though pressure outside the seal is no more than atmospheric the net force of the pressure tending to push the center conductor in toward the vacuum side of the seal places the ceramic window **27** and its brazed edges under compression. Also as previously pointed out the edges of the ceramic window **27** at the points where they are brazed to the metal lie in indented portions of the conductors. This is advantageous since in a coaxial transmission line voltage gradients exist everywhere in the coaxial space but are greatest near the center conductor and this is the point at which voltage breakdown is most likely to be initiated. As previously described the shaping of all the metal parts is such as to produce graceful curvatures of the conductors in the vicinity of the brazes. On the vacuum side a slightly larger curvature of the metal conductors is tolerable since the voltage breakdown threat is less than in the pressurized portion of the conductor.

In order to provide exceptionally good mechanical properties for the window and particularly in so far as mechanical strength and support is needed during brazing and bakeout operations common to joints of the general type under consideration, a hollow cylindrical ceramic plug **30** is provided inside the hollow tubular inner conductor **14** which is inserted inside the end of the opposite inner conductor **16**. In a like manner a cylindrical ring **31** is provided around the outer periphery of the upper end of the outer conductor **15** in such a manner that it substantially surrounds the braze portions between the outer conductors **13** and **15** and the window **27**. The inner support plug **30** and outer support ring **31** are provided to force the metals in the area of the window section **12** to follow closely the expansions and contractions of the ceramic material of the window **27** which results from temperature changes. A common material for any window such as the window **27** is any one of the commercially available high alumina ceramics. Obviously the ceramic plug **30** and a ceramic ring **31** made of the same material as that of the window **27** perform the desired function very well provided their strength is adequate to force the metal parts to undergo the motions involved. This may be a function of the size of the conductors involved, however, the supporting plug **30** is generally strong enough to perform this function since it is placed under compression when the section **12** is heated. However, the ring **31** outside the outer conductor may not be strong enough if the outer conductor is quite large and if the ceramic used is not strong enough to withstand the stresses in tension to which it is exposed. If such is the case the outer ring **31** may be made of stainless steel or other suitable material. However, the outer ring should be placed in tension in order to force copper to follow the ceramic.

While a particular embodiment of the invention has been illustrated and described it will of course be understood that the invention is not limited thereto since many modifications both in the circuit arrangement and instrumentalities employed may be made. For example, a vacuum seal is shown inside the inner conductor **14** and **16**. This is deliberate since a metal seal may be brazed into the structure at any convenient place. Further, it may be desirable to circulate a coolant within this inner conductor. It is contemplated that the appended claims will cover any such modifications as fall within the true spirit and scope of this invention.

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

1. In combination in a guided wave transmission line window and its supporting structure, first and second coaxial waveguide means for joining two waveguide systems, said first and second coaxial waveguide means including first and second hollow cylindrical outer conductors respectively and first and second hollow cylindrical inner conductors respectively, said first and second inner conductors having similar substantially conical nose portions which slope inwardly provided at their ends, said second inner conductor having a substantially conical mating land turned out around its inner periphery to fit around the outer periphery of the conical nose portion on said first inner conductor, said first and second outer conductor having similar turned out portions around the inner periphery of their ends, said first outer conductor having a substantially conical mating land formed around the outer periphery to mate with the turned out portion on the inner periphery of said second outer conductor, the respective inner and outer conductors of said first and second waveguides being positioned with mating portions in engagement to form a continuous waveguiding structure with indentations around the inner periphery of said outer conductors at the vacuum tight joint and the outer periphery of said inner conductors at the vacuum tight joint, and a dielectric window of substantially uniform thickness having the configuration of a truncated cone positioned in said waveguiding structure with its outer circular edge secured in the indentation around said outer conductor and its inner circular edge secured in the indentation around said inner conductors thereby to form a vacuum tight seal and microwave window between said first and second transmission lines.

2. In a guided wave transmission line window and support assembly for joining two transmission line systems which systems may be operated at different pressures, the combination of first and second coaxial waveguide means including first and second hollow cylindrical outer conductors respectively and first and second inner conductors respectively coaxially disposed with respect to said outer conductors, said outer conductors being positioned end to end and joined together to provide a vacuum tight joint and continuous conductive path and said inner conductors positioned with ends together and joined to form a vacuum tight joint and continuous conductive path whereby a continuous coaxial waveguiding structure is formed, the ends of said inner and outer conductors being shaped to form indentations around the periphery inside said transmission lines and at the vacuum tight joints which indentations have no sharp corners, when said conductors are joined and a substantially frusto-conical dielectric window of substantially uniform thickness positioned within said waveguiding structure with its outer circular edge in the indentation in the outer conductor of said waveguiding structure and its inner circular edge in the indentation around said inner conductor to form a vacuum tight seal and microwave window between said first and second transmission lines, the convex surface of said window being directed toward the high pressure side whereby said window is placed in compression.

3. A guided wave transmission line window and support assembly for joining two transmission line systems which systems may be operated at different pressures including in combination, first and second coaxial waveguide means having first and second hollow cylindrical outer conductors respectively and first and second inner conductors respectively coaxially disposed with respect to said outer conductors, said outer conductors being positioned end to end and joined together to provide a vacuum tight joint and continuous conductive path, a ring shaped support member positioned around the outer periphery of said two outer conductors at the joint to reinforce said joint, said inner conductors positioned with ends together and joined to form a vacuum tight joint and continuous conductive path whereby a continuous coaxial waveguiding structure is formed, the ends of said inner and outer conductors being shaped to form indentations around the periphery inside said transmission lines at the joints which indentations have no sharp corners, and a substantially frusto-conical dielectric window of substantially uniform thickness positioned within said waveguiding structure with its outer circular edge in the indentation in the outer conductor of said waveguiding structure and its inner circular edge in the indentation around said inner conductor to form a vacuum tight seal and microwave window between said first and second transmission lines.

4. A guided wave transmission line window and support assembly for joining two transmission line systems which systems may be operated at different pressures including in combination, first and second coaxial waveguide means having first and second hollow cylindrical outer conductors respectively and first and second tubular inner conductors respectively coaxially disposed with respect to said outer conductors, said outer conductors being positioned end to end and joined together to provide a vacuum tight joint and continuous conductive path, a ring shaped support member positioned around the outer periphery of said two outer conductors at the joint to reinforce said joint, said inner conductors positioned with ends together and joined to form a vacuum tight joint and continuous conductive path whereby a continuous coaxial waveguiding structure is formed, a cylindrical support plug positioned inside said tubular inner conductors at the joint, the ends of said inner and outer conductors being shaped to form indentations around the periphery inside said transmission lines at the joints which indentations have no sharp corners, and a substantially frusto-conical dielectric window of substantially uniform thickness positioned within said waveguiding structure with its outer circular edge in the indentation in the outer conductor of said waveguiding structure and its inner circular edge in the indentation around said inner conductor to form a vacuum tight seal and microwave window between said first and second transmission lines.

5. A guided wave transmission line window and support assembly for joining two transmission line systems which systems may be operated at different pressures including in combination, first and second coaxial waveguide means having first and second hollow cylindrical outer conductors respectively and first and second tubular inner conductors respectively coaxially disposed with respect to said outer conductors, said outer conductors being positioned end to end and joined together to provide a vacuum tight joint and continuous conductive path, said inner conductors positioned with ends together and joined to form a vacuum tight joint and continuous conductive path whereby a continuous coaxial waveguiding structure is formed, a cylindrical support plug positioned inside said tubular inner conductors at the joint to reinforce the said joint, the ends of said inner and outer conductors being shaped to form indentations around the periphery inside said transmission lines at the joints which indentations have no sharp corners, and a substantially frusto-conical dielectric window of substantially uniform thickness positioned within said waveguiding structure with its outer circular edge in the indentation in the outer conductor of said waveguiding structure and its inner circular edge in the indentation around said inner conductor to form a vacuum tight seal and microwave window between said first and second transmission lines.

6. In combination in a guided wave transmission line window and its supporting structure, first and second coaxial waveguide means for joining two waveguide systems, said first and second coaxial waveguide means including first and second hollow cylindrical outer conductors respectively and first and second hollow cylindrical inner conductors respectively, said first and second inner conductors having similar substantially conical nose portions which slope inwardly provided at their ends, said second inner conductor having a substantially conical mating land turned out around its inner periphery to fit around the outer periphery of the conical nose portion on said first inner conductor, said first and second outer conductor having similar turned out portions around the inner periphery of their ends, said first outer conductor having a substantially conical mating land formed around the outer periphery to mate with the turned out portion on the inner periphery of said second outer conductor, the respective inner and outer conductors of said first and second waveguides being positioned with mating portions in engagement to form a continuous waveguiding structure with indentations around the inner periphery of said outer conductors at the vacuum tight joints and the outer periphery of said inner conductors at the vacuum tight joints, a cylindrical support plug positioned inside said hollow inner conductor and extending at least over the area of engagement to reinforce the joint thus formed, and a dielectric window of substantially uniform thickness having the configuration of a truncated cone positioned in said waveguiding structure with its outer circular edge secured in the indentation around said outer conductor and its inner circular edge secured in the indentation around said inner conductors thereby to form a vacuum tight seal and microwave window between said first and second transmission lines.

7. In combination in a guided wave transmission line window and its supporting structure, first and second coaxial waveguide means for joining two waveguide systems, said first and second coaxial waveguide means including first and second hollow cylindrical outer conductors respectively and first and second hollow cylindrical inner conductors respectively, said first and second inner conductors having similar substantially conical nose portions which slope inwardly provided at their ends, said second inner conductor having a substantially conical mating land turned out around its inner periphery to fit around the outer periphery of the conical nose portion on said first inner conductor, said first and second outer conductor having similar turned out portions around the inner periphery of their ends, said first outer conductor having a substantially conical mating land formed around the outer periphery to mate with the turned out portion on the inner periphery of said second outer conductor, the respective inner and outer conductors of said first and second waveguides being positioned with mating portions in engagement to form a continuous waveguiding structure with indentations around the inner periphery of said outer conductors at the vacuum tight joint and the outer periphery of said inner conductors, at the vacuum tight joint, a ring shaped support member snugly positioned around the outer periphery of said two outer conductors and extending at least over the area of engagement to reinforce the joint thus formed, and a dielectric window of substantially uniform thickness having the configuration of a truncated cone positioned in said waveguiding structure with its outer circular edge secured in the indentation around said outer conductor and its inner circular edge secured in the indentation around said inner conductors thereby to form a vacuum tight seal and micro-

wave window between said first and second transmission lines.

8. In combination in a guided wave transmission line window and its supporting structure, first and second coaxial waveguide means for joining two waveguide systems, said first and second coaxial waveguide means including first and second hollow cylindrical outer conductors respectively and first and second hollow cylindrical inner conductors respectively, said first and second inner conductors having similar substantially conical nose portions which slope inwardly provided at their ends, said second inner conductor having a substantially conical mating land turned out around its inner periphery to fit around the outer periphery of the conical nose portion on said first inner conductor, said first and second outer conductor having similar turned out portions around the inner periphery of their ends, said first outer conductor having a substantially conical mating land formed around the outer periphery to mate with the turned out portion on the inner periphery of said second outer conductor, the respective inner and outer conductors of said first and second waveguides being positioned with mating portions in engagement to form a continuous waveguiding structure with indentations around the inner periphery of said outer conductors at the vacuum tight joint and the outer periphery of said inner conductors at the vacuum tight joint, a cylindrical support plug positioned inside said hollow inner conductor and extending at least over the area of engagement, a ring shaped support member snugly positioned around the outer periphery of said two outer conductors and extending over at least the area of engagement, said ring support member and said support plug being provided to reinforce the joint formed between the said first and second coaxial waveguide means, and a dielectric window of substantially uniform thickness having the configuration of a truncated cone positioned in said waveguiding structure with its outer circular edge secured in the indentation around said outer conductor and its inner circular edge secured in the indentation around said inner conductors thereby to form a vacuum tight seal and microwave window between said first and second transmission lines.

9. In combination in a guided wave transmission line window and its supporting structure, first and second coaxial waveguide means for joining two waveguide systems, said first and second coaxial waveguide means including first and second hollow cylindrical outer conductors respectively and first and second hollow cylindrical inner conductors respectively, said first and second inner conductors having similar substantially conical nose portions which slope inwardly provided at their ends, said second inner conductor having a substantially conical mating land turned out around its inner periphery to fit around the outer periphery of the conical nose portion on said first inner conductor, said first and second outer conductor having similar turned out portions around the inner periphery of their ends, said first outer conductor having a substantially conical mating land formed around the outer periphery to mate with the turned out portion on the inner periphery of said second outer conductor, the respective inner and outer conductors of said first and second waveguides being positioned with mating portions in engagement to form a continuous waveguiding structure with indentations around the inner periphery of said outer conductors at the vacuum tight joint and the outer periphery of said inner conductors at the vacuum tight joint, the slope of said conical nose portions on said inner conductors and the slope of the said turned out portions around the inner periphery of said outer conductors being such that the intersecting surfaces meet at substantially right angles when the said conductors are engaged, and a dielectric window of substantially uniform thickness having the configuration of a truncated cone positioned in said waveguiding structure with its outer circular edge secured in the indentation around said outer conductor and its inner circular edge secured in the indentation around said inner conductors thereby to form a vacuum tight seal and microwave window between said first and second transmission lines.

10. In combination in a guided wave transmission line window and its supporting structure, first and second coaxial waveguide means for joining two waveguide systems, said first and second coaxial waveguide means including first and second hollow cylindrical outer conductors respectively and first and second hollow cylindrical inner conductors respectively, said first and second inner conductors having similar substantially conical nose portions which slope inwardly provided at their ends, said second inner conductor having a substantially conical mating land turned out around its inner periphery to fit around the outer periphery of the conical nose portion on said first inner conductor, said first and second outer conductor having similar turned out portions around the inner periphery of their ends, said first outer conductor having a substantially conical mating land formed around the outer periphery to mate with the turned out portion on the inner periphery of said second outer conductor, the respective inner and outer conductors of said first and second waveguides being positioned with mating portions in engagement to form a continuous waveguiding structure with indentations around the inner periphery of said outer conductors at the vacuum tight joint and the outer periphery of said inner conductors at the vacuum tight joint, the slope of said conical nose portions on said inner conductors and the slope of the said turned out portions around the inner periphery of said outer conductors being such that the intersecting surfaces meet at substantially right angles when the said conductors are engaged, a cylindrical support plug positioned inside said hollow inner conductor and extending at least over the area of engagement to reinforce the joint thus formed, and a dielectric window of substantially uniform thickness having the configuration of a truncated cone positioned in said waveguiding structure with its outer circular edge secured in the indentation around said outer conductor and its inner circular edge secured in the indentation around said inner conductors thereby to form a vacuum tight seal and microwave window between said first and second transmission lines.

11. In combination in a guided wave transmission line window and its supporting structure, first and second coaxial waveguide means for joining two waveguide systems, said first and second coaxial waveguide means including first and second hollow cylindrical outer conductors respectively and first and second hollow cylindrical inner conductors respectively, said first and second inner conductors having similar substantially conical nose portions which slope inwardly provided at their ends, said second inner conductor having a substantially conical mating land turned out around its inner periphery to fit around the outer periphery of the conical nose portion on said first inner conductor, said first and second outer conductor having similar turned out portions around the inner periphery of their ends, said first outer conductor having a substantially conical mating land formed around the outer periphery to mate with the turned out portion on the inner periphery of said second outer conductor, the respective inner and outer conductors of said first and second waveguides being positioned with mating portions in engagement to form a continuous waveguiding structure with indentations around the inner periphery of said outer conductors at the vacuum tight joint and the outer periphery of said inner conductors at the vacuum tight joint, the slope of said conical nose portions on said inner conductors and the slope of said turned out portions around the inner periphery of said outer conductors being such that the intersecting surfaces meet at substantially right angles

when the said conductors are engaged, a ring shaped support member snugly positioned around the outer periphery of said two outer conductors and extending at least over the area of engagement to reinforce the joint thus formed, and a dielectric window of substantially uniform thickness having the configuration of a truncated cone positioned in said waveguiding structure with its outer circular edge secured in the indentation around said outer conductor and its inner circular edge secured in the indentation around said inner conductors thereby to form a vacuum tight seal and microwave window between said first and second transmission lines.

12. In combination in a guided wave transmission line window and its supporting structure, first and second coaxial waveguide means for joining two waveguide systems, said first and second coaxial waveguide means including first and second hollow cylindrical outer conductors respectively and first and second hollow cylindrical inner conductors respectively, said first and second inner conductors having similar substantially conical nose portions which slope inwardly provided at their ends, said second inner conductor having a substantially conical mating land turned out around its inner periphery to fit around the outer periphery of the conical nose portion on said first inner conductor, said first and second outer conductor having similar turned out portions around the inner periphery of their ends, said first outer conductor having a substantially conical mating land formed around the outer periphery to mate with the turned out portion on the inner periphery of said second outer conductor, the respective inner and outer conductors of said first and second waveguides being positioned with mating portions in engagement to form a continuous waveguiding structure with indentations around the inner periphery of said outer conductors at the vacuum tight joint and the outer periphery of said inner conductors at the vacuum tight joint, the slope of said conical nose portions on said inner conductors and the slope of the said turned out portions around the inner periphery of said outer conductors being such that the intersecting surfaces meet at substantially right angles when the said conductors are engaged, a cylindrical support plug positioned inside said hollow inner conductor and extending at least over the area of engagement, a ring shaped support member snugly positioned around the outer periphery of said two outer conductors and extending over at least the area of engagement, said ring support member and said support plug being provided to reinforce the joint formed between the said first and second coaxial waveguide means, and a dielectric window of substantially uniform thickness having the configuration of a truncated cone positioned in said waveguiding structure with its outer circular edge secured in the indentation around said outer conductor and its inner circular edge secured in the indentation around said inner conductors whereby to form a vacuum tight seal and microwave window between said first and second transmission lines.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,058,074

October 9, 1962

John Frederick Kane

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 7, line 45, after "joint" insert -- to reinforce the said joint --.

Signed and sealed this 9th day of April 1963.

EAL)
est:

TON G. JOHNSON
esting Officer

DAVID L. LADD
Commissioner of Patents

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