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ULTRA HIGH FREQUENCY COUPLER BETWEEN CONTIGUOUS
ENDS OF ALIGNED WAVE GUIDE SECTIONS
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Fig. 1.

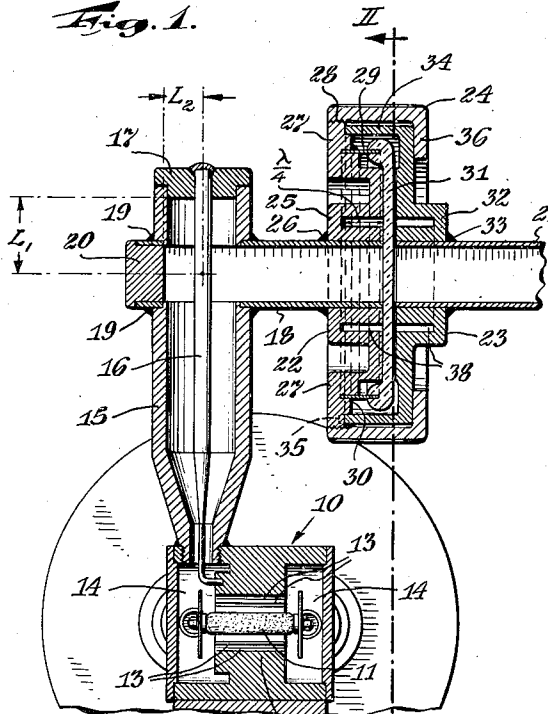


Fig. 3.

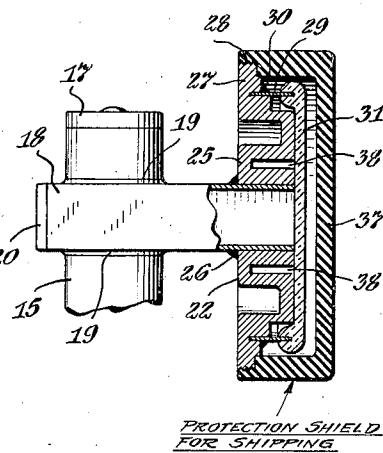


Fig. 2.

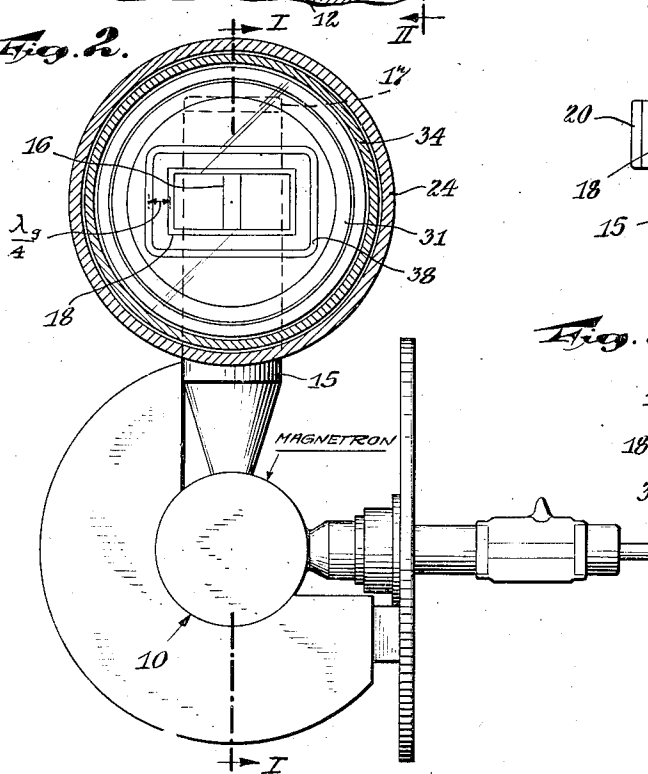


Fig. 4.

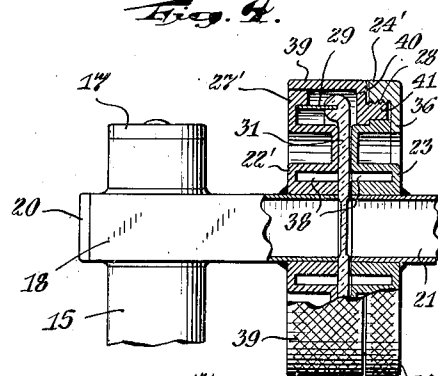
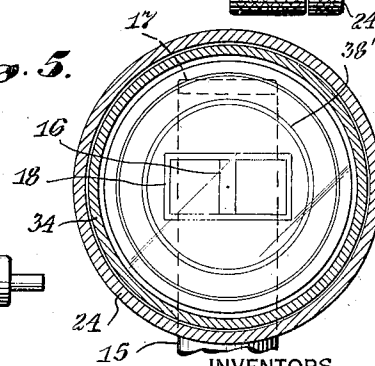


Fig. 5.



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ULTRA HIGH FREQUENCY COUPLER BETWEEN CONTIGUOUS ENDS OF ALIGNED WAVE GUIDE SECTIONS

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4 Claims. (Cl. 178-44)

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This invention relates to cavity joints and more particularly to joints between hollow instrumentalities such as sections of wave guides and a generator the outlet of which is of hollow character.

The use of wave guides for purpose of transfer of radio or ultra high frequency energy from place to place is an accomplished fact. It is, however, important that there be continuity for the mode of propagation along the wave guide from the generator to the instrument to which the energy is being conveyed. Screw threaded joints are generally inefficient when used in lines conveying R. F. currents. Prior practice has been to obtain surface continuity by soldering or otherwise definitely sealing all joints. That procedure is satisfactory for the electrical conductivity requirements, but has its deficiencies from practical considerations. Principal among the shortcomings of the prior art is the difficulty in making changes, additions and substitutions in the assembly. Another adverse condition encountered in the prior art is the frequent situations encountered making access to joints for obtaining a good soldering thereof extremely difficult. A wave guide generally is air filled, whereas the generator is evacuated and prior practice has been to provide some form of concentric line through a seal from the evacuated generator to the non-evacuated wave guide. This has presented both mechanical and electrical difficulties. In its most general aspects, therefore, the invention seeks to overcome the deficiencies, drawbacks and difficulties of the prior art.

More specifically, an object of the invention is to improve upon the prior art arrangements effecting the mechanical and electrical coupling of a generator or other evacuated instrumentality to a wave guide.

Another object of the invention is to provide a mechanical coupling and joint which also vacuum seals the generator.

A further object of the invention is to provide such a mechanical coupling which permits use of a threaded connection as the releasable means for interchange of generator or other purposes.

Yet another object of the invention is to provide a construction which functions as a mechanical and electrical coupling from generator to wave guide and as a vacuum seal for the generator.

Still further objects of the invention will appear as the description progresses, both by direct reference thereto and by implication from the context.

Referring to the accompanying drawing in

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which like numerals of reference indicate similar parts throughout the several views;

Figure 1 is a sectional view, as on line I—I of Fig. 2 of a generator and wave guide showing the invention therewith;

Figure 2 is a sectional view taken on line II—II of Fig. 1;

Figure 3 is a sectional view of the coupling member forming part of the generator and showing a protection shield applied thereon for shipping or storage purposes;

Figure 4 is a sectional view similar to Fig. 1 and showing a modified construction of coupling members; and

Figure 5 is a sectional view similar to Fig. 2 and showing a modified configuration of impedance matching slot.

In the specific embodiment of the invention illustrated in said drawing, and describing the structure of Figs. 1 and 2 initially, the reference numeral 10 designates generally an ultra high frequency wave generator, and which, in this particular showing is a magnetron. Such a generator includes a more or less hollow interior under vacuum and in which is situated a cathode 11 parallel to a generally cylindrical anode 12 wherein are provided a series of cavities 13 opening toward the cathode and also opening into end spaces 14 in the magnetron. An output extends from one of these end spaces 14, and is, as shown, usually a coaxial line consisting of a tubular outer member 15 and a coaxial rod or inner member 16 longitudinally therein and coextensive therewith. The end of the inner member 16 is shown extending into end space 14 and bent laterally for support in an appropriate socket in the anode, whereas the outer end of said inner member is carried at the middle of a cap 17 closing the outer end of the outer member. Heretofore it has been general practice to provide a ceramic seal, such as a glass bead, in the outer member as near the magnetron as practicable, the bead sealing onto the inner member as well as the outer member, the result of which has been to have one end portion of the output under vacuum and the other end under atmospheric pressure. Inclusion of such a bead has not only represented mechanical difficulties but also a loss of efficiency due to absorption of the energy developed in the magnetron. According to the present invention, the entire interior of the outer member 15 is constituted a continuous cavity and is under vacuum and includes no insulative bead whatever. End cap 17 is of metal and is located a distance L₁ from the center of the guide corresponding to a

definite series reactance in conjunction with the cap 20 at distance L_2 providing the requisite radiation resistance for whatever operating point is chosen for the magnetron.

Extending laterally from the coaxial line output is a wave-guide section 18 of rectangular cross-section that it may be responsive to and selective of desired mode of wave propagation. The dimensions of both the coaxial line output and the wave guide have definite relation to the wave length compatible to the generator and of wave length desired for propagation in the wave guide.

The outer member 15 of the coaxial line and the wave guide section are sealed, as by solder 19 at the joint therebetween. One end of the wave guide section is also sealed with a plug 20. At the other end of the wave-guide section is another wave guide section 21 aligned with the first section which is sealed thereat and which provides means for mechanically and electrically coupling the sections. This means constitutes an essential feature of the present invention. A primary consideration is to seal the first wave-guide section vacuum tight and permit application of a second section, which is open to atmospheric pressure, such that the coupling and uncoupling of the joint does not affect or destroy the vacuum retaining characteristic of the first section.

Exemplary of means accomplishing the desideratum just set forth, the substantially abutting ends of the wave-guide sections 18, 21 or other instrumentalities are mechanically coupled with a clamping ring 24 securing those members together. More in detail, one said member 22 on the section 18 of wave guide carried by the coaxial line and magnetron, provides a sleeve-like body portion 25 snugly fitting upon the marginal end of said member so the outer or front ends of said body portion and wave-guide section are substantially flush. These parts are securely soldered, as at 26. While the opening through the body portion of said member is rectangular for obtaining the fitting engagement and support of the member upon the wave-guide section, the perimetric rim 27 of said member has a circular contour and is screw threaded at 28. The construction likewise is such that said rim 27 is spaced rearwardly from the plane of the aforesaid front flush faces of member and wave-guide end. The forward face of the rim is likewise well rearward from said plane.

Vacuum-tight sealing of the wave-guide section 18 is obtained by a seal with respect to the forward face of said member 22. As shown, the forward face of rim 27 of said member 22 is provided with a circular groove in which the rear margin of a cylindrical metallic collar 29 is seated and sealed, as by solder 30. The forward edge of said collar extends substantially to the aforesaid plane of the forward flush ends of member and wave-guide. A glass or other dielectric or capping means such as disc 31 situated substantially in said plane across the end of the wave-guide, has its rim sealed on the forward margin of said collar 29. By preference said collar is an alloy primarily of iron, nickel, cobalt and manganese described in Patent 2,062,335 of Dec. 1, 1936, and the glass is preferably a boro-silicate glass having an expansivity of 3.0 to 6.5×10^{-6} centimeters per centimeter per degree centigrade to substantially equal the expansivity of the alloy. The construction shown enables the glass capping to be in actual contact with the forward face of the member 22.

Complementary member 24 of the coupling is

shown with a sleeve-like body portion 32 snugly fitting upon the rear marginal end of the wave-guide section 21 so that its rear face and the rear end of the section are substantially flush that is, are in a common plane, and may be brought into close proximity to or contact with the forward face of the capping disc 31. These parts are securely soldered, as at 33. While the opening through the body portion 32 of said complementary member 24 is rectangular for obtaining the fitting engagement and support of the member upon the wave-guide section 21, the perimetric rim of said member is formed as a cylindrical rearwardly directed flange 34 large enough to pass the edge of the capping disc 31 and have its rear edge seat against the forward face of the rim 27 of the first-described primary member 22. This construction obtains exact spacing of the respective body portions of said members and prevents pressure being applied against the glass of the capping disc when said members are clamped together. By appropriately shouldering the forward face of the rim 27 of the primary member to receive the end edge of the flange 34 of the complementary member, the members will be precisely centered, and may be oriented angularly of the axis by a suitable lug 35 (shown in dotted lines in Fig. 1) projecting from the edge of the flange 34 into a corresponding socket in the rim 27.

Said members are clamped together when desired to assemble a second section 21 of wave guide to the magnetron-mounted section 18, by clamping ring 24 the peripheral wall of which overlies the flange 34 of the complementary member and the inner edge margin of which is screw threaded to engage with threads 28 on the periphery of the rim 27 of the primary member. An inwardly directed wall 36 of this clamping ring engages on the forward face of complementary member and presses that member against its seat on the rim 27. Unscrewing of this clamping ring releases said members, but in no wise disturbs the vacuum seal of the capping disc or the magnetron-mounted section. A suitable protection shield 37 may be provided to be applied to threads 28 and overlie the capping disc when the magnetron is shipped or left unattached from a second wave-guide section.

Each body portion 25, 32 of said members 22, 23, has a slot 38 therein which opens toward the capping disc, said slots being directly opposed to each other and each completely engirdling its respective wave-guide section. As shown in Fig. 2, said slots preferably parallel the waveguide wall nearest thereto, so in end view said slot is shown as a rectangle. However, said slots may be circular, and exemplary thereof a circular slot 38' is shown in Fig. 5. Otherwise the structure of Fig. 5 is the same as heretofore described with respect to Figs. 1 to 3. In any event, the slot has a depth parallel to the wave guide which is equal to substantially a quarter-wave length of the waves in air or vacuum. Furthermore, the slot is preferably at approximately a distance outward from the wave-guide equivalent to a quarter wave-length of the wave in the glass or other medium comprising capping disc 31 and which, in the case of a glass disc, results in a much shorter wave-length therein than in air or vacuum. Accordingly, from wave guide to the bottom of said slot, represents a path of half a wave length. As a result, a very low impedance appears at the gap between the ends of the wave-guide sections, and as a result those ends present the equivalent of electrical continuity for practically unimpaired

transfer of the radio frequency from the first section 18 to the second section 21.

Fundamentally the construction of Figure 4 is the same as that heretofore described, the differences being of a mechanical character for affording a measure of protection to the capping disc when the coupling members are disconnected. As shown in Fig. 4, accordingly wave-guide sections 18 and 21 are arranged as before, each having a coupling member 22' and 23' secured thereon and provided with a slot 38 therein of quarter wave-length depth. Rim 27' of the primary member 22' receives and retains a cylindrical metallic collar 29, preferably of the aforementioned alloy to which is sealed capping disc 31, preferably of boro-silicate glass. This disc, as before, is preferably in the plane of and contact with the forward face of the primary member and end of the first wave-guide section, and substantially fills the gap between the two members and wave-guide sections in the region between the wave guides and slots as before.

The difference in construction of the showing of Fig. 4 over the previously described construction is to be found in provision of a separately formed peripheral housing 39 of cylindrical configuration and appropriate size to be applied around the periphery of rim 27' and soldered or otherwise secured thereto. This housing extends forwardly to also overlie the edge of the capping disc, out of contact therefrom, and shoulders inward, at 40 and then forwardly at 41 with a smaller diameter so as to be permanently in front of the margin of the capping disc and thereby protect said disc. The forward projection 41 is externally screw threaded at 28' and receives clamping ring 24', an inwardly directed wall 36' of which overlies the complementary member 23' and holds it in place as will be understood from description of Figures 1 and 2. Lug and socket, slot and key, or other orienting means are also provided.

The embodiments of the invention selected for present illustration accordingly provide a permanent seal for the end of a wave-guide section which opens into a coaxial line from a magnetron or other generator enabling said generator, coaxial line and wave-guide section to all be evacuated as a single operation. Furthermore the construction eliminates obstruction to energy transfer in the coaxial line and affords a single effective means for transfer from the wave-guide section to a contiguous section with said means having the added function of mechanically coupling said sections.

We claim:

1. A cavity joint comprising contiguous wave guide sections each having its walls aligned with the walls of the other section, a coupling member on each said section on the contiguous ends thereof, and a dielectric capping means between said members and sealed with respect to one of the same and extending across the contiguous ends of both of the wave guide sections, one of said members providing a slot opening toward the said dielectric capping means a distance from the wall of the wave guide section substantially equal to a quarter wave length in the dielectric.

2. A cavity joint comprising contiguous wave guide sections each having its walls aligned with the walls of the other section, a coupling member on each said section on the contiguous ends thereof, and a dielectric capping means between said members and sealed with respect to one of the same and extending across the contiguous

ends of both of the wave guide sections, one of said members providing a slot opening toward the said dielectric capping means a distance from the wall of the wave guide section substantially equal to a quarter wave length in the dielectric, said slot having a quarter wave length depth, whereby a low impedance is reflected through slot and dielectric to the gap between sections occupied by said dielectric for obtaining effective electrical continuity to radio frequency across the gap from one section to the other.

3. A cavity joint comprising wave guide sections positioned endwise one to the other thereby providing contiguous ends, each section having walls in common planes with walls of the other section, and providing a gap between contiguous end of said sections, a coupling member on the exterior of each of said sections next the contiguous ends thereof and providing a continuation of said gap laterally outward from said sections, each said member having a wave-guide opening therethrough, a dielectric capping means in said gap sealing one said opening of one said member and extending laterally outward beyond said wave guide and between said coupling members, said capping means having a peripheral rim entirely outside of and remote from said wave guide and sealed with respect to said one member, and one of said members having a slot exterior to and completely girdling the wave guide in parallelism thereto and at a distance therefrom substantially equal to a quarter wave length in the dielectric and intersecting said dielectric between the rim of the dielectric and the wave guide.

4. A cavity joint comprising wave guide sections positioned endwise one to the other thereby providing contiguous ends, each section having walls in common planes with walls of the other section, and providing a gap between contiguous ends of said sections, a coupling member on the exterior of each of said sections next the contiguous ends thereof and providing a continuation of said gap laterally outward from said sections, each said member having a wave-guide opening therethrough, a dielectric capping means in said gap sealing one said opening of one said member and extending laterally outward beyond said wave guide and between said coupling members, said capping means having a peripheral rim entirely outside of and remote from said wave guide and sealed with respect to said one member, and one of said members having a slot of depth substantially equal to a quarter wave length in air, said slot being exterior to and completely girdling the wave guide in parallelism thereto and at a distance therefrom substantially equal to a quarter wave length in the dielectric and intersecting said dielectric between the rim of the dielectric and the wave guide.

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