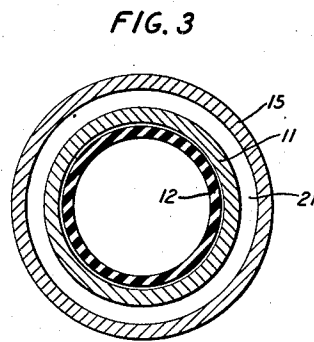
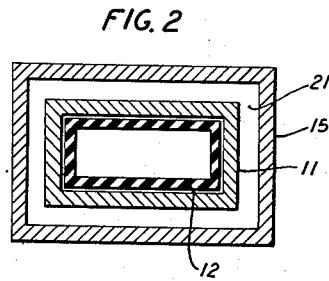
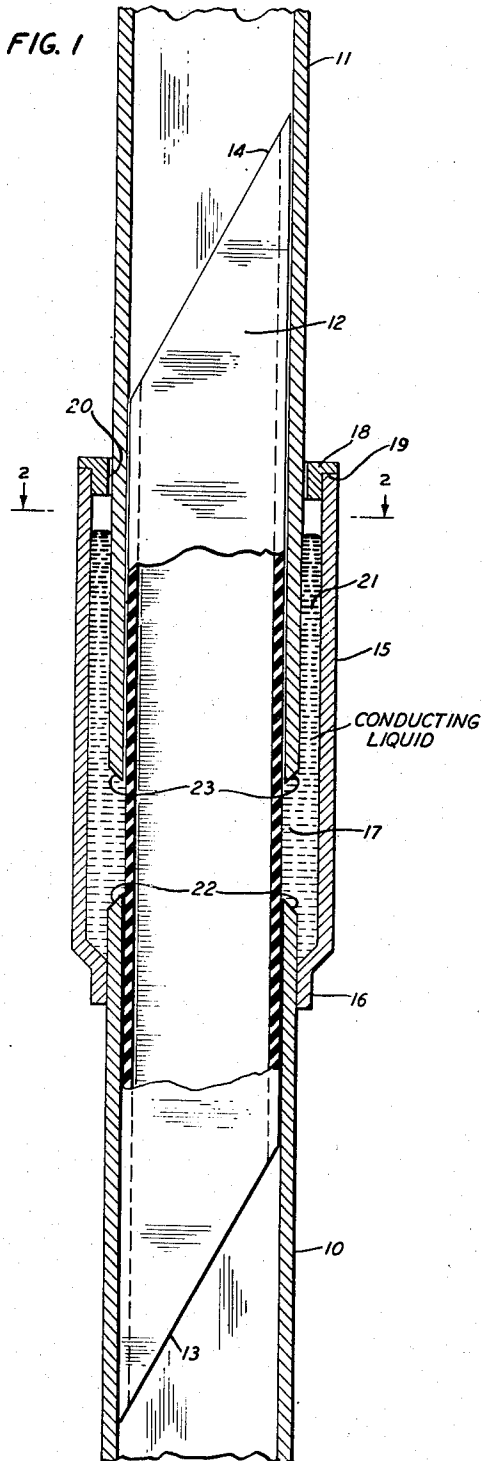


Aug. 14, 1951

L. HOCHGRAF
COUPLING FOR WAVE GUIDES

2,564,007

Filed Nov. 14, 1947



INVENTOR
BY L. HOCHGRAF

Halter B. Kiesel

ATTORNEY

UNITED STATES PATENT OFFICE

2,564,007

COUPLING FOR WAVE GUIDES

Lester Hochgraf, Maplewood, N. J., assignor to
Bell Telephone Laboratories, Incorporated, New
York, N. Y., a corporation of New York

Application November 14, 1947, Serial No. 785,890

6 Claims. (Cl. 178-44)

1

This invention relates to wave transmission systems and more particularly to couplings for wave guides for transmitting high frequency electromagnetic waves.

An object of this invention is to reduce the reflection of transmitted energy at the joint between two sections of a wave guide.

Another object of this invention is to join sections of wave guide or similar structure by a coupling which has relatively low transmission losses.

Accordingly, this invention provides a coupling or joint between two sections of wave guide having identical cross sections, this coupling being made up of a quantity of conducting liquid constrained to a form providing an inner wall continuous with the walls of the guide by a low-loss thin-walled dielectric tube having its ends inserted in the adjacent ends of the wave-guide sections and in slidable relation with one of said sections. The conducting fluid is maintained around the dielectric tube by a jacket, also in slidable relation with one of said sections, enclosing a portion of the ends of the sections.

The various features of this invention will be better understood from the following detailed description when considered in conjunction with the accompanying drawings in which:

Fig. 1 discloses a sectional view of a coupling for wave-guide sections illustrative of one embodiment of the invention;

Fig. 2 is a cross section of the coupling of Fig. 1 taken along the line 2-2 of Fig. 1; and

Fig. 3 is a cross section of a modification of the coupling of Fig. 1 in which the wave guides and coupling are circular, the section being taken along a line corresponding to 2-2 of Fig. 1.

Referring to the drawing, a portion of an electromagnetic transmission system including the coupling of this invention and a part of two rectangular wave-guide sections 10 and 11 are shown. Suitably secured within section 10 is a thin-walled low-loss dielectric tube 12 of suitable material, for example, polystyrene, having outer dimensions substantially equal to the inner dimensions of the wave guide. The length of this dielectric tube 12 is considerably longer than the maximum extension for which the particular coupling is constructed. The tube 12 extends from section 10 into section 11 in close fitting slidable relation with the interior of said section 11. The ends 13 and 14 of tube 12 are tapered in order to provide a gradual transition of the dielectric within the interior of the wave-guide system across the coupling from that of all air to that of air and the material of the tube. This gradual transition of the dielectric interior of the wave guide has been found to be a very satisfactory means of providing for the gradual

2

change in impedance which, if abrupt, would produce transmission losses across the joint.

The coupling is encased by a tubular member 15 which is constricted at 16 and is secured by some suitable means to the exterior of section 10. This casing 15 extends across the gap 17 between the sections and beyond a distance determined by the extension for which the coupling is constructed but in any event approximating the distance that the dielectric tube 12 extends within section 11. A guide ring 18 is secured within the casing 15 at its end 19. This ring has an inner dimension substantially equal to the outer dimensions of the section 11 and is arranged so that the surface 20 of its inner surface will slide over the outer surface of section 11. Thus, the ring 18 in cooperation with the dielectric tube 12 forms a support which maintains section 11 in axial alignment with section 10 throughout any relative movement between the sections. A circular wave guide and joint as shown in Fig. 3 permits rotary as well as axial movement.

The gap 17 between the sections 10 and 11 is bridged electrically by a conducting liquid 21 which is confined therein by the enclosure formed by the outer walls of the dielectric tube 12 and the wave guide sections 10 and 11 in cooperation with the casing 15 surrounding these portions. In order to provide a smooth continuous conducting surface comprised of the inner wall of section 10, the liquid across the gap, and the inner wall of section 11, it is necessary to reduce to a minimum any meniscus in the conducting liquid which might appear at the edges 22 and 23 of the sections; therefore, the edges of the sections are beveled as shown in the drawings and are of such material as will be wetted by the liquid. Since it is necessary that the dielectric tube slides freely within the section 11 without the liquid leaking at this point a close fit is necessary between the dielectric tube and the wave guide; if the dielectric and the inner conductor surface over which it slides are of such material as will not be wetted by the liquid, the fit between the tube and the conductors can be considerably looser than it need be otherwise to maintain a leakproof fit.

As one embodiment of this invention, it is contemplated coupling guide sections of brass or copper by a liquid section of mercury. Since mercury will amalgamate with either copper or brass, weakening the structure of the metal and contaminating the mercury so that it readily oxidizes when exposed to air to form a semisolid substance, it is obvious that the copper or brass must be protected from the mercury. It is also desirable that no surfaces of the guide sections which are contacted by the mercury except the edges 22 and 23 be wetted thereby. A satisfac-

tory solution to these problems has been developed by employing a platinum coating on the edges 22 and 23, this coating being chemically inactive with, yet wetted by the mercury. The rest of the inner and outer portions of the wave-guide sections can be kept from contact with the mercury by using a lacquer or other non-metallic covering which mercury does not wet. In order to further protect the wave-guide sections, it has been found advisable, especially where the lacquer covering is exposed to any abrasive effects such as that of the dielectric liner sliding over the interior of section 11 and that of the ring 18 sliding over the exterior of section 11, to provide an inner coating such as a dense non-porous plating of iron which mercury will not attack even though the lacquer coating is scratched or worn in use. The use of stainless steel as the material of the outer casing 15 and the ring 18 eliminates any difficulty as to amalgamation and wetting and provides a strong reinforcing member maintaining the alignment of wave-guide sections 10 and 11.

The use of this coupling requires that a quantity of conducting liquid be maintained within the casing 15 sufficient to cover the portion of the dielectric tube 12 exterior of the wave-guide sections at all degrees of extension or contraction. This can be done in a vertical joint as shown in the drawing by constructing the outer jacket with a capacity for such an amount of liquid, that when the joint is at its greatest extension, the level of the liquid remains above the edge 23 and at its minimum extension, the level of the liquid is below the ring 18. In a horizontal joint, however, either the upper side of the jacket must be enlarged to form a liquid reservoir or a separate reservoir is necessary in order to supply enough liquid so that at the greatest extension of the joint, the liquid surface is above the upper side of the dielectric tube 12.

In practice, it has been found that the introduction of a thin-walled, tapered-end, low-loss dielectric tube as described causes very little change in the impedance within a wave guide, and that the use of a section of guide wall having a considerably greater resistivity than that of the major portion of the guide, as when mercury is used across the gap between the two copper sections, has practically no effect on the transmission of the system and very little change of impedance within the guide. Thus a coupling is provided having highly satisfactory electrical characteristics which joins two sections of a wave guide so that at all extensions of the wave guide, a continuous inner conducting surface is provided allowing movement as would be necessary, for example, in a long run of wave guide where means must be provided for expansion and contraction, or where adjustments of the length of the wave guide are necessary to achieve the desired operating characteristics.

As many possible embodiments may be made of the above invention and as many changes might be made in the embodiment above set forth, it is to be understood that all matter hereinbefore set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. A wave-guide coupling for a pair of spaced wave guide sections comprising a dielectric member fitted within the adjacent ends of said sections in fluid-tight relationship therewith, and a

quantity of electrically conductive fluid maintained around the portion of said dielectric member exterior of said guide sections.

2. A wave-guide coupling for a pair of spaced axially aligned wave-guide sections comprising a low-loss dielectric liner closely fitted into the adjacent ends of said sections, a jacket surrounding the adjacent ends of said sections and the exposed portion of said liner, and a quantity of conductive fluid contained in said jacket sufficient to cover the exposed portion of said liner and the ends of both wave-guide sections whereby the electrical continuity of the inner conducting surface of the guide is maintained.

3. A wave-guide coupling for a pair of spaced wave guide sections comprising a low-loss dielectric liner closely fitted into the adjacent ends of said sections and having its ends tapered, a jacket enclosing the adjacent ends of said sections and the exposed portion of said dielectric liner, and a quantity of conductive fluid contained in said jacket sufficient to cover the exposed portion of said liner and the ends of both wave-guide sections.

4. A wave-guide coupling for two axially aligned wave-guide sections comprising a third axially aligned wave-guide section having electrically conductive fluid walls, a low-loss dielectric member closely fitted into the adjacent ends of said first two wave-guide sections, and an outer jacket encasing the adjacent ends of said wave-guide sections and maintaining the conducting fluid about the surface of said dielectric member exterior of said first two wave-guide sections.

5. A variable length wave-guide coupling for joining two axially aligned wave-guide sections comprising a third axially aligned wave-guide section having electrically conductive fluid walls, a low-loss dielectric tube tapered at both its ends and having one end secured in one of said first two wave-guide sections and the other end closely fitted in slidable relation in the other of said first two wave-guide sections, and an outer jacket encasing the adjacent ends of said wave-guide sections and maintaining the conducting fluid about the surface of said dielectric member exterior of said first two wave-guide sections.

6. A wave-guide coupling for a pair of axially aligned wave-guide sections having like cross-sections comprising a low-loss dielectric liner having an outer cross-section substantially the same as the inner cross-section of said wave-guide sections, said dielectric liner being secured within one of said sections and mounted in close fitting slidable relation with the other of said sections, an outer jacket secured to the end of one of said sections and enclosing a portion of said other section, and a quantity of conductive fluid maintained within said jacket sufficient to cover the exposed outer surface of said dielectric liner and thereby provide an inner conducting surface continuous with and bridging the inner surfaces of the guide sections.

LESTER HOCHGRAF.

REFERENCES CITED

The following references are of record in the file of this patent:

70

UNITED STATES PATENTS

Number	Name	Date
2,424,545	Bard	July 29, 1947
2,433,368	Johnson	Dec. 30, 1947