June 21, 1949. W. G. TULLER 2,473,834

COUPLING BETWEEN TRANSMITTER AND WAVE GUIDE SYSTEM

Filed Jan. 25, 1944

FIG. 1.

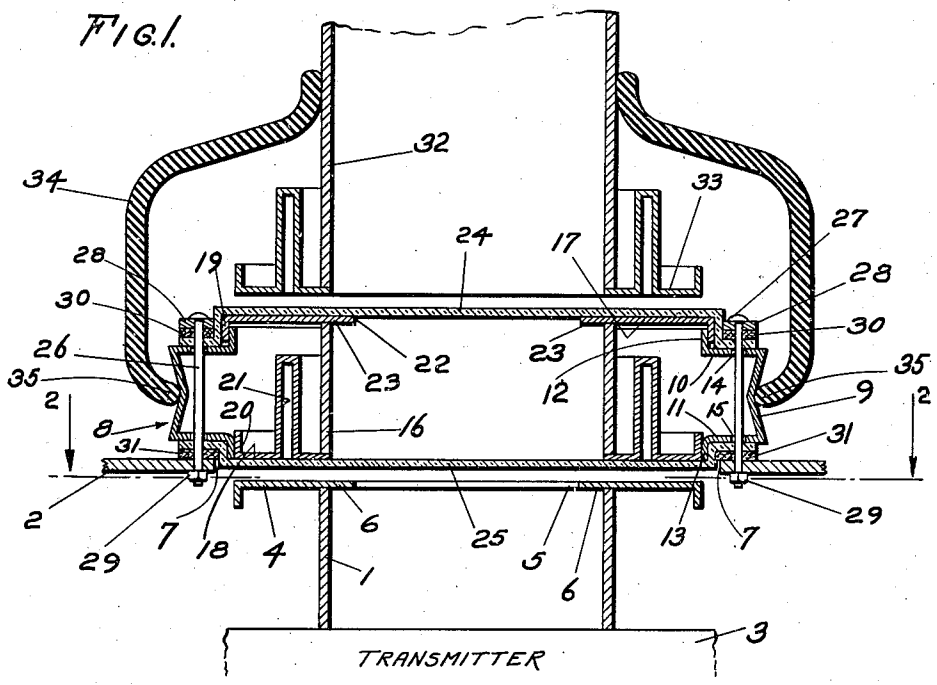


FIG. 2.

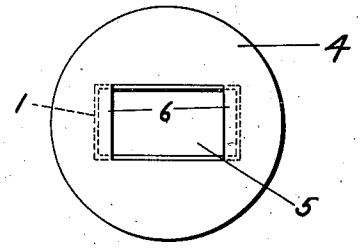
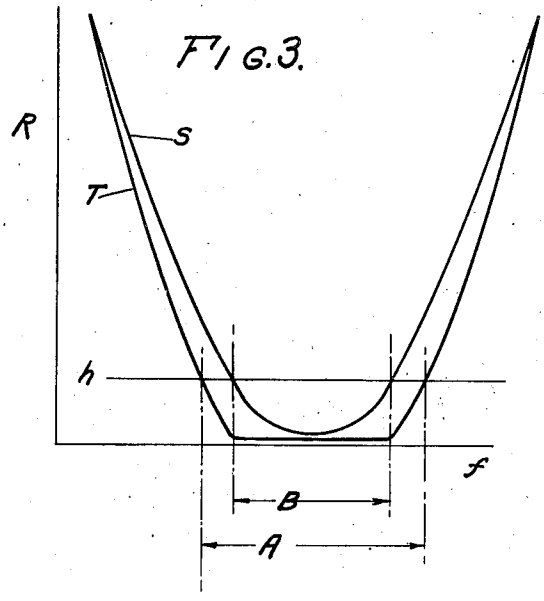


FIG. 3.



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COUPLING BETWEEN TRANSMITTER AND WAVE GUIDE SYSTEM

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8 Claims. (Cl. 178—44)

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This invention relates to guided electromagnetic wave transmission, and more specifically to a means providing a fluid-tight seal for guided wave transmission lines to prevent the entrance of moisture, or other foreign matter, to the line or other parts of the system, such as the transmitter and receiver.

In many installations of ultra high frequency equipment, for example on ships, it is desirable to completely enclose the transmitter, the receiver, or both, in a fluid-tight housing to prevent the entrance of moisture or other foreign matter which would adversely affect the operation of the system, or its durability. Since in such installations the wave guide must pass through the housing, a sealed connection must be made between the portion of the wave guide within the housing and the portion exterior thereto leading to the antenna, otherwise fluid or other foreign matter may enter the system at the joint between these two portions. It is desirable to permit a slight relative motion between the sections of the wave guide leading to the antenna and the sections within the housing containing the transmitting equipment. However, if this is effected by leaving a slight clearance between the section of the wave guide within the housing and the portion exterior thereto, the value of the housing is nullified since moisture or other foreign matter may enter through this clearance.

It is an object of this invention to provide a structure which will permit slight relative movements of the housing of such a system relative to the portion of the wave guide exterior thereto, and which at the same time provides a fluid-tight connection without introducing material electrical losses or otherwise impairing the efficiency or durability of the transmission line or the transmitting system with which it is associated.

It is a further object of the invention to provide a device of the type described which will permit the transmission of ultra-high frequency oscillations without decreasing the available band width to which the system is responsive.

The above and other objects and features of the invention will be made fully apparent to those skilled in the art from a consideration of the following detailed description taken in conjunction with the accompanying drawing in which:

Fig. 1 represents a longitudinal section through a fluid-tight joint for a guided wave transmission line constructed in accordance with the present invention;

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Fig. 2 represents on a reduced scale a section taken on the line 2—2 of Fig. 1; and

Fig. 3 shows a set of curves which in a general qualitative way illustrate certain operating characteristics of the present invention.

In the drawing, reference numeral 1 indicates a portion of a guided wave transmission line within the housing 2 of a transmitting system indicated diagrammatically at 3. It will be understood that the system 3 may include various elements such as the receiving system or portions thereof, and any other elements which it is desired to protect, as well as the transmitter.

In the instance shown, the wave guide section 1 is of rectangular cross-section, but it will be understood that the invention may be applied to guided wave transmission systems having transmission lines of other types. A coupling flange 4 mounted upon the end of the wave guide section 1, as for example by soldering, is provided with a rectangular opening 5 in the central portion thereof, which opening is of somewhat less length than the greatest transverse dimension of the wave guide and of substantially the same width as the narrowest dimension of said wave guide. Accordingly, the open end of the section 1 is partially obstructed by the portions 6 of the flange 4 overlying the section 1.

The section 1 is supported from the chassis of the transmitter 3 independently of the housing 2, so that this housing may be readily removed from the transmitter structure and the associated wave guide section 1.

The housing 2 is provided with a circular opening 7 adjacent to and of somewhat greater diameter than the diameter of the flange 4. The opening 7 is closed by a sealing structure comprising a tubular member 8 having an intermediate inwardly indented portion 9. The tubular member 8 is of metal, such as brass, and is bent inwardly on each side of the intermediate indented portion 9 to provide shouldered portions 10 and 11 adjacent the upper and lower ends thereof, respectively. An upwardly projecting rim 12 extends for a short distance from the upper shouldered portion 10 and a similar rim 13 projects downwardly from the lower shouldered portion 11. A series of openings 14 are provided adjacent the periphery of the upper shouldered portion 10, and similar openings 15, in alignment with the openings 14, are provided in the lower shouldered portion 11.

A wave guide section 16, having substantially the same transverse dimensions as the wave guide section 1, is positioned centrally within the tubu-

lar structure 8 and maintained in position relative thereto by means of coupling flanges 17 and 18 fixed to the upper and lower ends, respectively, of the wave guide section 16, as, for example, by soldering. The flange 17 is provided with a downwardly projecting rim 19 at the outer peripheral edge thereof, which rim is soldered to the upwardly projecting rim 12 of the tubular member 8. The lower coupling flange 18 is provided with an upwardly projecting rim 20 at its outer peripheral edge adapted to be soldered or otherwise fixed to the downwardly projecting rim 13 of the tubular member 8. The flange 18 is provided with an annular reentrant portion 21 intermediate the wave guide section 16 and the outer peripheral rim 20. It will be observed that the upper coupling flange 17 of the section 16 is constructed in substantially the same manner as the previously described flange 4 of the wave guide section 1, it being provided with a central rectangular opening 22 of somewhat less length than the longer dimension of the wave guide section 16, so that the wave guide section 16 is partially obstructed by strips 23 in the same manner that the wave guide section 1 is partially obstructed by the projecting strips 6.

A sheet of polystyrene or similar insulating material 24 closes the opening 22 at the upper end of the wave guide section 16, said sheet being of sufficient diameter to cover the flange 17 and extend downwardly about the peripheral rim 19 thereof and thence outwardly across the upper shouldered portion 10. A similar sheet of insulating material 25 closes the lower end of the wave guide section 16 and is bent upwardly and outwardly adjacent its peripheral edge to conform to the lower shouldered portion 11. The sheets of insulating material 24 and 25 are secured in position flush with the outer surfaces of the flanges 17 and 18 by means of tie rods 26 which extend through perforations adjacent the peripheral edge of the sheets 24 and 25 and through the openings 14 and 15 in the shouldered portions 10 and 11. The tie rods 26 are provided at one end with heads 27 which bear upon a clamping ring 28 and are provided at the opposite ends thereof with nuts 29 which may be screwed on the threaded ends of the tie rods, which ends project through perforations in the housing 2 adjacent the opening 7. If desired, a gasket 30 of cork or other suitable material may be interposed between the clamping ring 28 and the sheet 24 and a similar gasket 31 may be interposed between the housing 2 and the sheet 25.

It will be evident that for the purpose of sealing the housing 2 against the entrance of moisture and other foreign matter, it would be sufficient to provide but one of the insulating sheets 24 or 25 closing one end or the other of the wave guide section 16. I have found, however, that if two such insulating sheets are utilized and these are properly spaced, as hereinafter described, then the width of available wave band, which the system is capable of transmitting, is materially increased over the width of the band which would be transmitted if but a single insulating sheet were used. Thus, if the length of wave guide section 16 is such that the sheets 24 and 25 are spaced a distance substantially equal to one-quarter of the length of the wave on the wave guide or to an odd multiple of one-quarter wave length, then the width of the frequency band which may pass through the system without undue attenuation is substantially 30 per cent greater than if but a single sheet were used.

The advantage to be derived from the use of two sheets of the insulating material spaced as described will be better appreciated after a consideration of the set of curves shown in Fig. 3, in which the curve S represents in a general qualitative manner the relative amount of the reflection R as plotted against the frequency f, when a single sheet of insulating material such as 24 or 25 is used in a system of the type described. The curve T represents the corresponding relative values of R and f when two such sheets 24 and 25 are utilized and spaced at a distance substantially equal to one-quarter of the length of the wave on the transmission line or any odd multiple of a quarter of such wave length. From these curves it will be seen that if the area below the level h represents a region in which the reflection R is sufficiently low to be permissable, then frequencies within the range A may be utilized in a system provided with the preferred form of the seal in which the two sheets 24 and 25 are spaced as described, while only frequencies within the range B, which is approximately 70 per cent of A, could be utilized in a system provided with only one such sheet.

A wave guide section 32 leading to the antenna is provided with a coupling flange 33 coacting with the flange 17. Structurally the coupling flange 33 is similar to the coupling flange 18 and is preferably positioned in a plane parallel to the plane of the sheet 24, and spaced therefrom at a distance of about one-eighth to one-quarter inch.

A flexible flange 34, preferably of rubber or similar material, is secured upon the wave guide 32 at a point above the coupling flange 33. The flexible flange 34 is provided with an outwardly flaring portion sufficiently large to enclose the coupling flange 33 and the upper part of the tubular member 8, and terminates in an inwardly projecting rim 35 adapted to contract into the indented portion 9 of the tubular member 8, thus providing a flexible fluid-tight shield between the wave guide section 32 and the tubular member 8. This construction permits small relative displacements between the wave guide section 32, leading to the antenna, and the wave guide section 16 which is fixed relative to the housing 2.

In operation, at the frequencies at which systems of this type are designed to function, I have found that the sheets 24 and 25 introduce a capacity effect which would not otherwise be present in the system, although the material from which the sheets are constructed possesses the most desirable characteristics of any material available. I have found that by providing the strips of conductive material 6 and 23 overlying and partially obstructing the wave guide, an inductance is provided which in any given instance may be made sufficient to match the capacitance of the sheets of insulating material.

It will be observed that the sealing structure comprising the tubular member 8 and the parts rigidly connected thereto may be assembled as a unit, and when this unit is secured to the housing structure 2 by the tie rods 26 the parts enclosed by said housing are completely sealed regardless of whether or not the device is connected to the section 32 of the antenna system. Thus, the transmitter and associated parts are sealed against the entrance of foreign matter while the same are being shipped or stored independently of the antenna system, and yet are

in condition for immediate connection to the antenna system, which is usually separately assembled and supported, by merely sliding the housing into position adjacent the section **32**. The flexible flange **34** is not essential in all instances, but is desirable where the system is so exposed that moisture or other foreign matter may be deposited on the face of the sheet **24** to an extent sufficient to introduce an undesirable impedance across the wave guide due to the electrical characteristics of the deposit. However, when used, the flange **34** may be readily flexed into position with the rim **34** stretched to resiliently engage the indented portion **9** of the tubular member **8**.

It will be understood that the invention is not limited to the particular details as described above as many equivalents will suggest themselves to those skilled in the art. It is therefore desired that the appended claims be given a broad interpretation commensurate with the scope of the invention within the art.

It will also be understood that by the expression "a distance substantially equal to an odd multiple of one-quarter of the length of the wave on the wave guide" and similar expressions as used in the appended claims, I intend to include the fundamental instance in which the distance is one-quarter of the wave length, the odd multiple being one.

What is claimed is:

1. A guided wave transmission system including in combination a transmitter, a housing enclosing said transmitter, a wave guide section connected to said transmitter and terminating adjacent an opening in said housing, a second wave guide section in registry with said first-mentioned section, a sheet of insulating material extending across said second wave guide section, said second section being spaced from said first-mentioned section and supported by said housing, a third wave guide section on the exterior of said housing spaced from and adapted to register with said second wave guide section, said third wave guide section being supported independently of said housing, and a flexible flange enclosing the gap between said second wave guide section and said third wave guide section.

2. A guided wave transmission system including in combination a transmitter, a housing enclosing said transmitter, a wave guide section connected to said transmitter and terminating adjacent an opening in said housing, a second wave guide section in registry with said first-mentioned section, a pair of sheets of insulating material extending across each end of said second wave guide section, said second section being spaced from said first-mentioned section and supported by said housing, a third wave guide section on the exterior of said housing spaced from and adapted to register with said second wave guide section, said third wave guide section being supported independently of said housing, and a flexible flange enclosing the gap between said second wave guide section and said third wave guide section.

3. A guided wave transmission system including in combination a transmitter, a housing enclosing said transmitter, a wave guide section connected to said transmitter and terminating adjacent an opening in said housing, a second wave guide section in registry with said first-mentioned section, a pair of sheets of insulating material extending across each end of said second wave guide section, said sheets of insulating material being spaced from each other a distance

substantially equal to an odd multiple of one-quarter of the length of the wave on the transmission system, a third wave guide section on the exterior of said housing spaced from and adapted to register with said second wave guide section, said third wave guide section being supported independently of said housing.

4. A guided wave transmission system including in combination a transmitter, a housing enclosing said transmitter, a wave guide section connected to said transmitter and terminating adjacent an opening in said housing, a second wave guide section in registry with said first-mentioned section, a pair of sheets of insulating material extending across each end of said second wave guide section, said sheets of insulating material being spaced from each other a distance substantially equal to an odd multiple of one-quarter of the length of the wave on the transmission system, a third wave guide section on the exterior of said housing spaced from and adapted to register with said second wave guide section, said third wave guide section being supported independently of said housing, and a flexible flange enclosing the gap between said second wave guide section and said third wave guide section.

5. A wave guide system for high-frequency electromagnetic waves including two wave guide sections, a third wave guide section, said third wave guide section having a length approximately equal to one-quarter of the length of the waves adapted to be transmitted by said system, said two wave guide sections being spaced by a distance slightly greater than the length of said third section whereby said third section is freely insertable therebetween, sheets of insulating material one extending across each end of said third wave guide section, and means to support said third wave guide section in spaced relation to each of said two wave guide sections.

6. A wave guide system for high-frequency electromagnetic waves including two wave guide sections, a third wave guide section detachably mounted between said two sections, said third wave guide section having a length approximately equal to one-quarter of the length of the waves adapted to be transmitted by said system, sheets of insulating material one extending across each end of said third wave guide section, and movable means enclosing the junction between one of said two wave guide sections and said third section.

7. A wave guide system for high-frequency electromagnet waves including two wave guide sections, a third wave guide section, said third wave guide section having a length approximately equal to one-quarter of the length of the waves adapted to be transmitted by said system, means to support said third wave guide section between and spaced from each of said two wave guide sections by a short gap, sheets of insulating material one extending across each end of said third wave guide section, and a flexible flange enclosing the gap between one of said two wave guide sections and said third section.

8. A wave guide system for high-frequency electromagnetic waves including two wave guide sections, a third wave guide section, said third wave guide section having a length approximately equal to one-quarter of the length of the waves adapted to be transmitted by said system, means to support said third wave guide section between and spaced from at least one of said two wave guide sections by a short gap, sheets of insulating material one extending across each end of said

third wave guide section, and a flexible flange enclosing the gap between said one of said two wave guide sections and said third section.

WILLIAM G. TULLER.

REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
1,541,601	Tribe	June 9, 1925
2,129,713	Southworth	Sept. 13, 1938

Number	Name	Date
2,151,157	Schelkunoff	Mar. 21, 1939
2,165,961	Cork et al.	July 11, 1939
2,223,082	Van Mierlo	Nov. 26, 1940
2,312,919	Litton	Mar. 2, 1943
2,374,498	Quayle	Apr. 24, 1945
2,375,223	Hansen	May 8, 1945
2,400,777	Okress	May 21, 1946
2,403,302	Richmond	July 2, 1946
2,407,069	Fiske	Sept. 3, 1946
2,407,318	Mieher	Sept. 10, 1946
2,408,271	Rigrod	Sept. 24, 1946

Certificate of Correction

Patent No. 2,473,834. June 21, 1949.

WILLIAM G. TULLER

It is hereby certified that errors appear in the printed specification of the above numbered patent requiring correction as follows:

Column 4, line 21, for "permissable" read *permissible*; column 6, lines 53 and 54, claim 7, for "electromagnet" read *electromagnetic*;

and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 22nd day of November, A. D. 1949.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.