ADJUSTABLE IMPEDANCE TRANSFORMER

Filed Oct. 12, 1948

INVENTORS
JOHANNES MARINUS VAN HOFWEEGEN
& KORNELIS SWIER KNOL

BY

AGENT
This invention relates to devices for the transmission of ultra-high frequency electromagnetic waves through dielectric conductors.

The conception of dielectric conductors is considered to comprise hollow tubes having a conductive wall and exhausted or filled with gas, liquid or a solid dielectric, as well as hollow tubes made of nonconductive material, so far the described conductors can be used for the transmission of ultra-high frequency electromagnetic waves.

In the transmission of electromagnetic waves along a dielectric conductor it is frequently not possible for the excitation means and/or the load on the conductor to be so proportioned as to ensure matching, that is to say to provide their impedance to be equal to the characteristic impedance of the conductor. The consequence of the load not being matched is that stationary waves occur in the conductor, resulting in additional losses. If stationary waves are avoided by matching of the load on the conductor, it is generally desirable that the excitation means should also be matched to the conductor, since in this case the energy transmission is a maximum.

Several suggestions have previously been made to reduce the losses by improvement of matching in devices of the above-mentioned kind. In a known device a dielectric auxiliary conductor including an adjustable piston is provided near the load on the dielectric conductor. In other known devices use is made of secondary radiators or diaphragms arranged in the vicinity of the unmatched load or excitation means.

However, these known means do not permit of obtaining perfect matching in any conditions. As is well-known, a device for acting upon the matching may be regarded as a transformer which transforms a determined impedance into a different impedance. In order to ensure correct matching in any cases occurring, it would be necessary to have the disposal of an adjustable impedance transformer capable of transforming any impedance into any other impedance. However, this is not practicable with the matching means hitherto known, which only permit transformations of impedances within certain boundaries in the complex plane.

Furthermore the known constructions have the disadvantage that the adjustability can be realised only with difficulty from the constructional point of view. Thus, for example, the area at which a dielectric auxiliary conductor is connected to the conductor to be matched can difficultly be made adjustable, while this area is required to be variable for the purpose of matching different loads.

The present invention provides a device which permits of carrying out any impedance transformations desired. It is thus possible, if desired, always to obtain correct matching. Furthermore the adjustability of the device can be made simpler from a constructional point of view.

The device according to the invention exhibits the characteristic that two dielectric conductors located at different sides of a common part of the side-wall are coupled with one another through an aperture of adjustable size provided in the common wall part, the extremities of the two conductors located near the aperture being closed by adjustable conductive pistons.

The invention will now be explained more fully by reference to the accompanying drawings in which Figs. 1, 2, 3, 4 and 5 show, by way of example, forms of the device according thereto.

In Fig. 1, the dielectric conductors 1 and 2 have a common wall part 3. The conductors exhibit a rectangular sectional area. The sectional area of the device in Fig. 1, which is indicated by I—I, is shown in Fig. 2. In the common wall part 3 is provided an aperture 4 through which the conductors 1 and 2 are coupled with one another. The aperture 4 is of adjustable size, for example in that one or more of the wall parts bounding the aperture are made slidable. The extremities 5 and 6 of the dielectric conductors 1 and 2, which are located near the aperture 4, are closed by adjustable conductive pistons 7 and 8. Now, any desired impedance transformation may be produced between the dielectric conductors 1 and 2 by adjustment of the size of the aperture 4 and of the position of the pistons 7 and 8. If, for example, the dielectric conductor 1 is connected to a horn-like radiator used for the transmission of electro-magnetic energy and if this horn has an impedance not equal to the characteristic impedance of the conductor 2, stationary waves will occur in the conductor 2 with direct connection of the horn-like radiator to this conductor as a result of the horn impedance not being matched. The use of the device according to the invention, however, enables the impedance of the horn-like radiator which differs from the characteristic impedance of the conductor 2, to be transformed into the characteristic impedance of this wave conductor. It is thus ensured that stationary waves cannot occur in the conductor 2. This transformation is effected, as already mentioned, by correct adjustment of the size of...
the aperture 4 and of the position of the pistons 7 and 8.

Fig. 3 shows a further form of device according to the invention. The extremities 15 and 16 of the conductors 11 and 12, which are located near the aperture 14 in the common wall part 13, are here provided at the same side of the aperture 14. It appears that thus any desired impedance transformation may be adjusted by means of only two movement mechanisms, of which one moves simultaneously the two pistons 17 and 18 and the other varies the size of the aperture 14 by movement of that portion of the common side-wall 13 which is located at the side of the aperture which is remote from the two pistons 17 and 18.

A particularly simple construction is obtained if that portion of the common side-wall which is located between the two pistons is omitted. The construction thus obtained is shown in Fig. 4. Two pistons are here combined to form one piston 37 which closes the extremities of the conductors 30 and 31 located near the aperture 34, the latter now extending to the piston. At any position of the piston 37, the aperture 34 is adjustable to any desired size by movement of the common wall part 32 of the conductors 30 and 31. The cross-sectional area indicated by II-III in Fig. 4, is shown in Fig. 5. It has been found that the device shown in Fig. 4 also permits of effecting any desired impedance transformation by the adjustment of the piston 31 and of the slideable part 32 of the wall.

As is well-known, two kinds of electromagnetic waves may occur in dielectric conductors, viz., one at which the electric field strength only has a transverse component (TE-waves) and one at which the magnetic field strength only has a transverse component (TM-waves).

The TE-waves which occur in the conductors 30 and 31 may be imagined to be decomposed into waves exhibiting in 30 and 31 an electric field strength which is in anti-phase as indicated by the arrows 38 and 40 and into waves at which this field strength is in phase as indicated by the arrows 41 and 42. The two first-mentioned waves which occur in 30 and 31 respectively are coupled to one another by waves produced in the space intermediate the piston 37 and the dotted line 43 and indicated by the arrow 39. The other waves which occur in 30 and 31 respectively cannot occur in the last-mentioned space; they are reflected at the dotted line 43.

The extent of coupling of the wave components occurring in anti-phase in the conductors 30 and 31 may be adjusted by displacement of the piston 37 and of the common part 32 of the wall. It has been found that adjustment of any desired impedance transformation is thus possible. The device shown in Fig. 1 may also be used with a method of oscillation in which the arrows 38, 39, 40, 41 and 42 do not indicate the electric field strength but indicate the magnetic field strength (TM-waves). The operation remains the same.

In order to reduce the reflection which occurs due to the conductors 30 and 31 being bent through a rectangle (which is, however, not essential to satisfactory operation of the device shown in Fig. 4) the angles 44 and 45 are made oblique. It is observed that this is already known per se.

Although in the examples shown use is made of dielectric conductors of rectangular sectional areas, it is quite possible to utilise conductors of different sectional area.

A device according to the invention may be adjusted in a simple manner according to tables or graphs or empirically for effecting any desired impedance transformation. Consequently, it is particularly useful in experimental arrangements with dielectric conductors for obtaining correct matching in testing excitation means and loads, such as aerials, horn-like radiators, and artificial loads provided for carrying out energy measurements and for realising impedances which are adjustable at will.

What we claim is:

1. An arrangement for guiding ultra-high-frequency waves comprising first and second dielectric wave guides terminating in adjacent portions provided with a common electrically conductive wall, said wall being adjustable longitudinally with respect to the termination of said portions and independently of the remaining walls of said guides to define a coupling section between said guides, and a piston slidably disposed within said section to vary the effective dimensions of said section.

2. An arrangement for guiding ultra-high-frequency waves comprising first and second co-linearly-disposed wave guides terminating in parallel portions positioned perpendicularly with respect to said colinear guides and provided with a longitudinally adjustable common conductive wall and an opening therebetween defining a wave guide section common to said first and second guides, and a piston slidably disposed within said section to vary the effective dimensions of said section.

3. An arrangement, as set forth in claim 2, wherein said guides have a rectangular cross-section and wherein said common wall extends without said guides to facilitate adjustment thereof.

JOHANNES MARINUS VAN HOPWEGEN.
KORNELIS SWIER KNOL.

REFERENCES CITED

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

<table>
<thead>
<tr>
<th>United States Patents</th>
<th>Number</th>
<th>Name</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,153,728</td>
<td>Southworth</td>
<td>April 11, 1939</td>
<td></td>
</tr>
<tr>
<td>2,283,335</td>
<td>King</td>
<td>May 26, 1942</td>
<td></td>
</tr>
</tbody>
</table>