

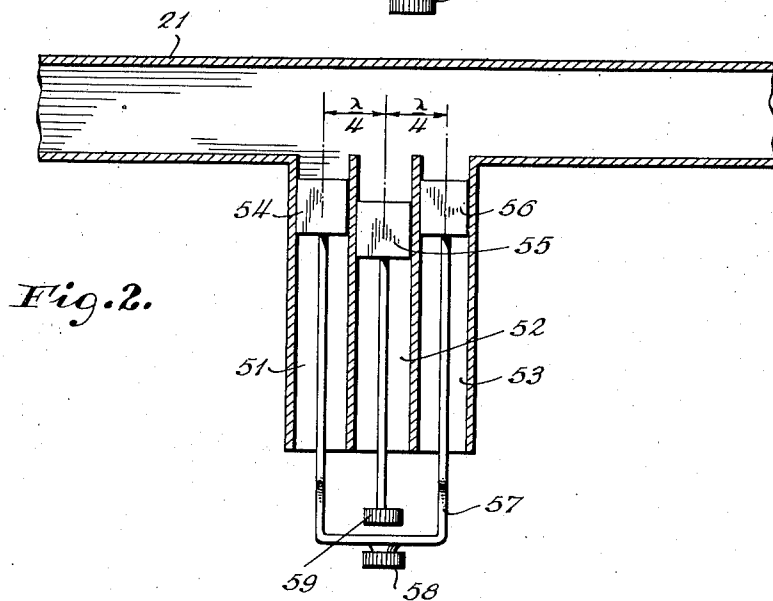
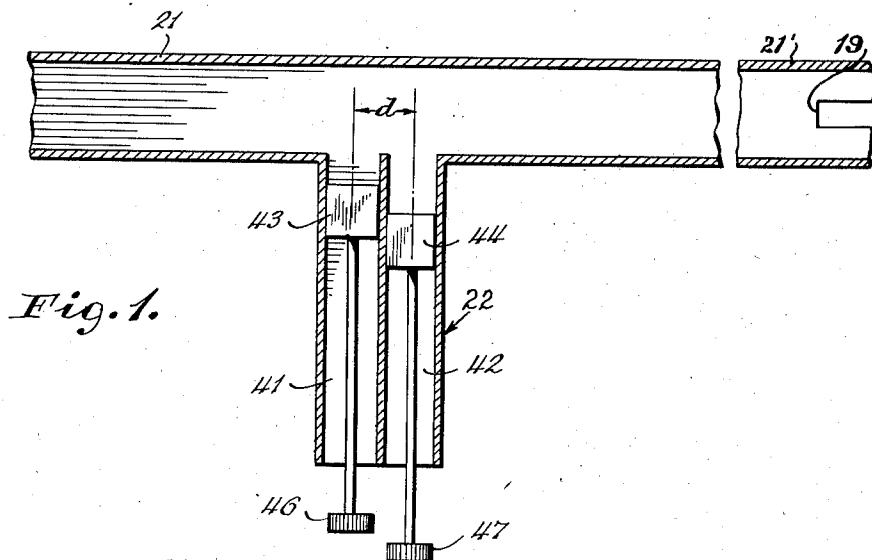
April 6, 1948.

W. W. HANSEN

2,438,914

WAVE GUIDE IMPEDANCE TRANSFORMER

Filed June 19, 1943



INVENTOR
WILLIAM W. HANSEN
BY *Paul B. Hunter*
ATTORNEY

UNITED STATES PATENT OFFICE

2,438,914

WAVE GUIDE IMPEDANCE TRANSFORMER

William W. Hansen, Garden City, N. Y., assignor
to The Sperry Corporation, a corporation of
Delaware

Application June 19, 1943, Serial No. 491,429

5 Claims. (Cl. 178-44)

1

The present invention relates to the art including impedance matching and transforming devices especially adapted for use in systems utilizing high frequency electromagnetic energy conducted in wave guides.

In transferring energy from one high frequency device to another, it is well known that the impedances thereof must be properly matched in order to avoid the production of standing waves, with their attendant increase in losses and decrease in the energy transmitting capacity of the system. In addition, for greater efficiency of power transfer, it is known that the impedance of a load device must be properly matched to that of the high frequency source.

The present invention is directed toward the provision of improved impedance transforming devices which are adapted to transform an impedance connected at one end to a different value at the other end of such a transforming device, whereby this transformed impedance may be matched to a load or other impedance connected at such other end.

Accordingly, it is an object of the present invention to provide improved impedance transformers for transforming a given impedance into a desired impedance.

Another object of the present invention is to provide an improved adjustable impedance transformer for use in the system having a maximum ease of adjustment and range of impedance transformation.

It is still another object of the present invention to provide an improved impedance transformer which is relatively insensitive to the changes in operating frequency.

Still another object of the present invention is to provide improved wave guide impedance transformers which are substantially independent of frequency over a considerable range of operation.

Other objects and advantages will become apparent from the following specification and drawings, in which

Fig. 1 shows a longitudinal cross-sectional view of one form of adjustable wave guide impedance transformer.

Fig. 2 shows a corresponding longitudinal cross-sectional view of another form of adjustable wave guide impedance transformer having an enlarged range of operation.

The present invention is useful especially in the connection between a high frequency source and a radiating wave guide. Such radiating wave guides in general require impedance matching devices to match them to the wave guides through which the input energy flows. Such devices form the present invention.

Fig. 1 shows a rectangular radiating wave guide 21' in cross-section, whose radiating slot begins at

2

the point 19 and which is attached to a main or principal rectangular wave guide 21 whose cross-section is equal to that of the radiating guide. It will be understood that, while my adjustable

5 wave guide impedance transformers are herein illustrated and described in connection with a radiating wave guide, this specific application is merely one manner wherein these transformers may be employed. Hence, this illustrative example should not be taken in a limiting or restrictive sense. It will be apparent from the following description that such transformers may be used with diverse kinds of utilization apparatus, generally characterized by the fact that the apparatus connected to one end of the transformer is of a complex impedance which is different from that of the apparatus connected to the other end.

An adjustable wave guide transformer is shown in Fig. 1, generally designated by the numeral 22, and comprising a pair of shunt or tap wave guides 41 and 42 communicating with the main wave guide 21. Each of these wave guides 41, 42 carries a sliding short-circuiting plunger 43 and 44, respectively slidable therein by manipulation of their adjustment knobs 46 and 47. Such a pair of adjustable shunt wave guides provides means for matching or transforming impedances over a substantial range, by suitably adjusting knobs 46 and 47 as required.

It has been found that when the distance d separating these shunt wave guides is substantially one-quarter-wavelength of the operating frequency, least sensitivity of adjustment is encountered; that is, adjustment of the knobs 46 and 47 produces relatively small change in impedance transformation, so that the device is relatively easy to adjust to a desired condition. However, for this quarter-wave relation, it has also been found that the range of impedance transformations attainable is somewhat restricted, so that not all impedance transformation values can be obtained.

By reducing the distance d , it is found that the range of permissible transformations increases, but, at the same time, the criticalness of adjustment of sliding pistons or plungers 43 and 44 increases, so that for too small a separation d the device becomes difficult to adjust accurately and to maintain in adjustment. A suitable compromise value has been found to be one-eighth of a wavelength, which is therefore the desired relation.

I have found that a wave guide impedance transformer which may be used to transform any arbitrary impedance connected at one end to any other arbitrary impedance may be constructed by providing a triple shunt wave guide arrangement instead of the double shunt wave guide arrangement hereinabove described. Thus, by the addi-

tion of one more adjustable wave guide in shunt with the principal guide and appropriately spaced from the pair of guides 41, 42, the range of impedances which can be transformed or matched is considerably extended.

Fig. 2 shows such an improved form of transformer similar to the device of Fig. 1, but in which three shunt wave guides are used, namely, 51, 52 and 53, each having its respective short-circuiting piston 54, 55 and 56. In practice the condition of impedance match or proper impedance transformation is most often tested by observing the standing wave ratio or the power output. Thus, in the device of Fig. 1, it will be clear that adjustments of the two plungers 43, 44 must be made by trial and error to produce the desired result. Usually this will be accomplished by setting one of the plungers, say plungers 43, to an intermediate optimum position, which generally, will not be the desired condition, and then resetting the other plunger to improve this optimum condition. Then, by alternately resetting each of the two plungers, the proper transforming condition may be obtained after a few manipulations.

However, when three adjustable plungers are presented for setting, as in the device of Fig. 2, the problem of finding the proper adjustment is greatly complicated by the introduction of one additional degree of freedom. To compensate for this inherent complication, pistons 54 and 56 are joined by a yoke 57 and are jointly operable by knob 58. Piston 55 is operable by the knob 59. It will be noted that the yoke 57 is off-set to permit the two knobs 58 and 59 to pass one another. Then, in operation, the three-plunger device is manipulated in substantially the same manner as the two-plunger transformer requiring only the independent adjustment of two plunger knobs thereby producing variations of three shunt wave guides. In this manner, I have widened the operable range of the wave guide impedance transformer without sacrificing the ease and simplicity of adjustment.

Preferably, the respective pistons are separated by one-quarter of a wavelength, and under these circumstances it has been found that the device will satisfactorily transform impedances over the entire range of desired transformations. Furthermore, the sensitivity of adjustment is such as to permit accurate and easy determination of the proper setting for the desired impedance transformation. Thus the device of Fig. 2 is to be preferred to that of Fig. 1.

While the devices of Figs. 1 and 2 have been described with respect to rectangular wave guides, it is to be noted that they can operate just as satisfactorily and in exactly the same manner with wave guides of other shapes, such as circular, elliptical, etc.

As many changes could be made in the above construction and many apparently widely different embodiments of this invention could be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. An adjustable wave guide impedance transformer comprising a principal wave guide section, a plurality of further wave guide sections connected in shunt with said principal section and respectively spaced apart a distance substantially equal to one-quarter wavelength at the operating frequency, an adjustable shorting means for each

of said further sections, and means for adjusting two of said shorting means independently of one another to transform an impedance at one end of said principal section to a desired value at the other end of said principal section.

2. An adjustable wave guide impedance transformer comprising a first section of wave guide, a plurality of shunt single-conductor hollow-pipe wave guide sections at least three in number communicating with said first section, adjustable shorting means for each of said shunt sections, means for simultaneously adjusting at least two of said shunt-section-shortening means, and means for independently adjusting another of said shunt-section-shortening means, whereby an impedance connected at one end of said first section may be transformed to a desired value at the other end of said first section.

3. An adjustable impedance transformer apparatus for wave guides comprising a first section of wave guide, three shunt single-conductor hollow-pipe wave guide sections communicating with said first section and consecutively spaced along said first section, adjustable shorting means for each of said shunt sections, means for adjusting the shorting means of the center one of said shunt sections, and means for simultaneously adjusting the shorting means of the outer ones of said three sections independently of said center-section-shortening means, whereby an impedance connected at one end of said first section may be transformed to a desired value at the other end of said first section by simultaneous adjustment of said outer sections and separate adjustment of the other of said shunt sections.

4. An adjustable wave guide impedance transformer for transforming an arbitrary impedance to any other desired impedance comprising a principal wave guide section, a plurality of further single-conductor hollow-pipe wave guide sections at least three in number in shunt with said principal section, an adjustable shorting means for each of said further sections, and means for conjointly adjusting two of said shortening means independently of the remainder of said plurality of shorting means.

5. An adjustable impedance transformer apparatus for wave guides comprising a first section of wave guide, three shunt wave guide sections communicating with said first section and consecutively spaced therealong substantially a quarter wavelength apart at the operating frequency of said apparatus, adjustable shorting means for each of said shunt sections, and means for simultaneously adjusting the outer ones of said three sections, whereby an impedance connected at one end of said first section may be transformed to a desired value at the other end of said first section by simultaneous adjustment of said outer sections and separate adjustment of the other of said shunt sections.

WILLIAM W. HANSEN.

REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
2,088,749	King	Aug. 3, 1937
2,106,768	Southworth	Feb. 1, 1938
2,106,769	Southworth	Feb. 1, 1938
2,155,508	Schelnkoff	Apr. 25, 1939
2,232,179	King	Feb. 18, 1941
2,284,529	Mason	May 26, 1942