March 6, 1956 L. LEWIN ET AL 2,737,634

WAVEGUIDE ELBOW

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FIG. 1.

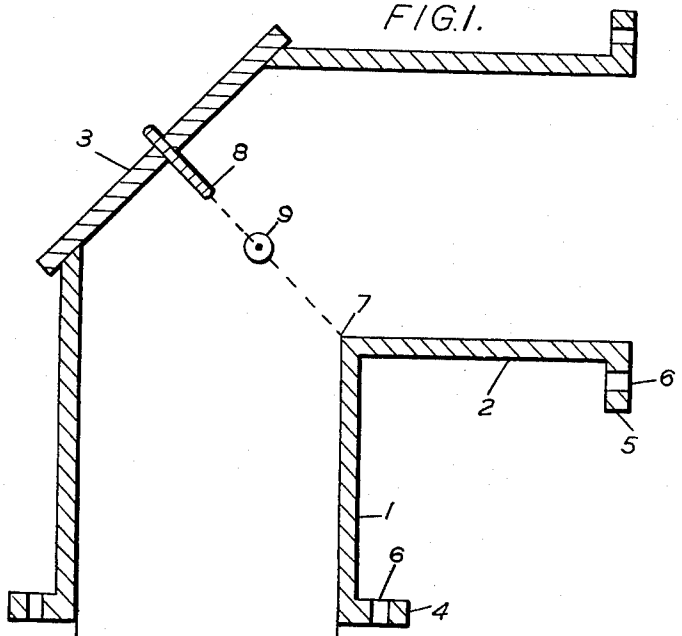


FIG. 2.

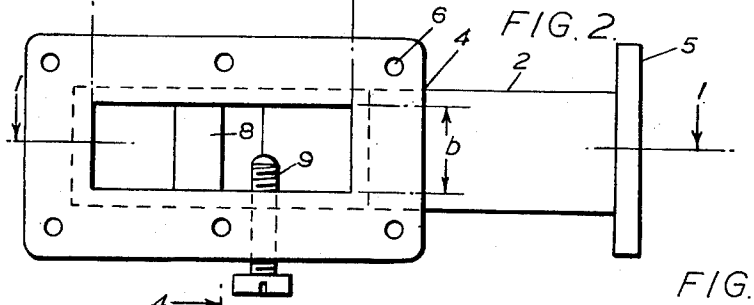


FIG. 4.

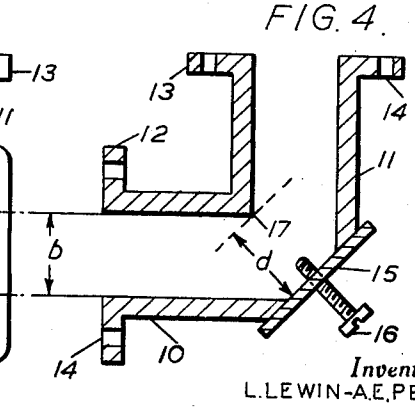
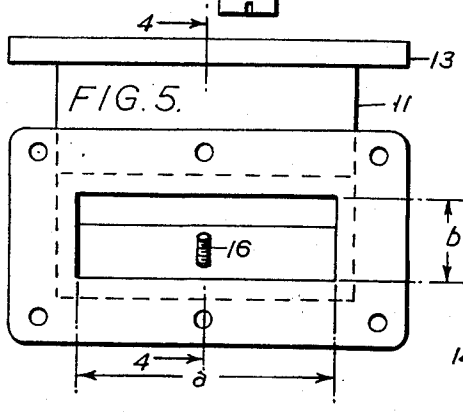


FIG. 5.



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FIG. 3.

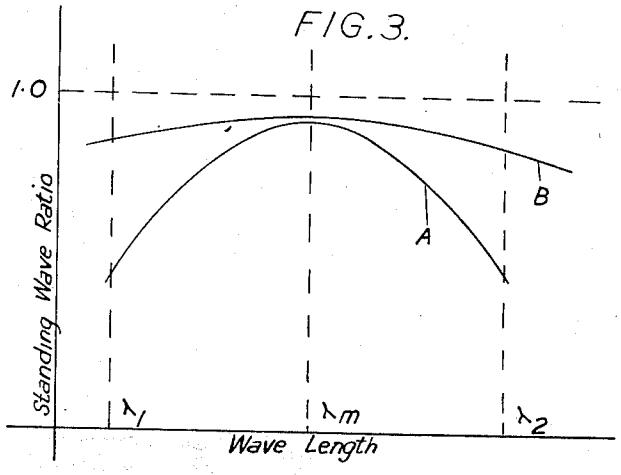


FIG. 6.

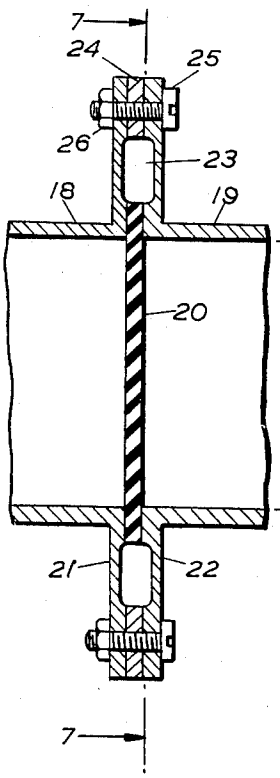
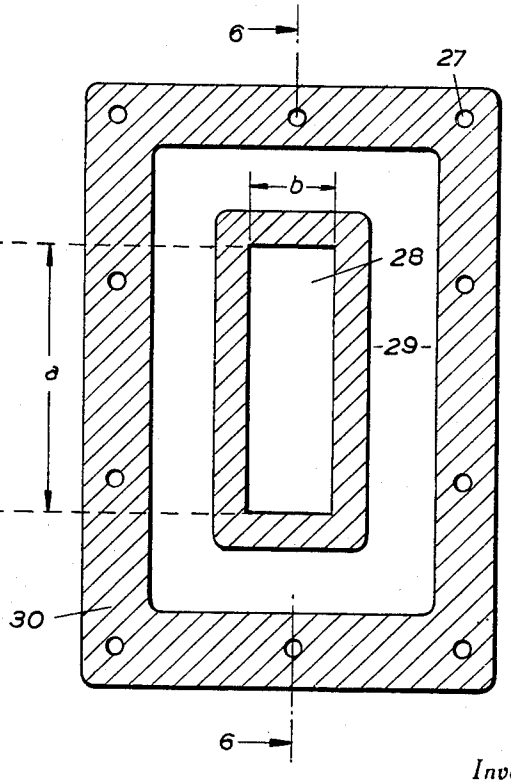


FIG. 7



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FIG. 9.

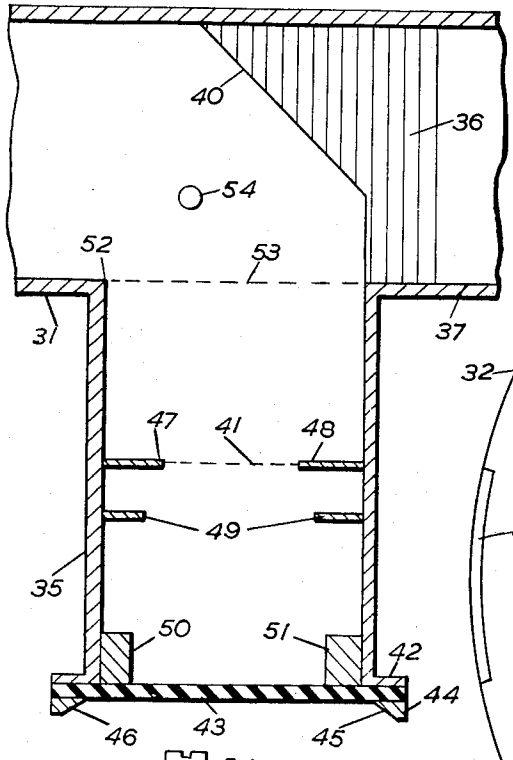


FIG. 10

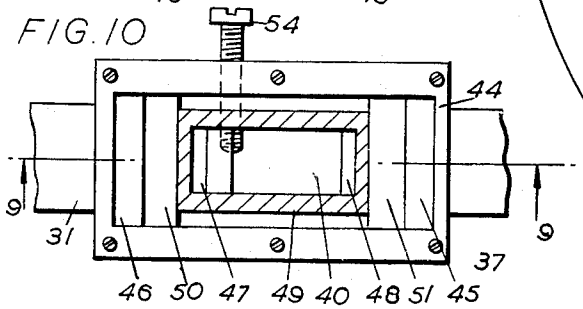
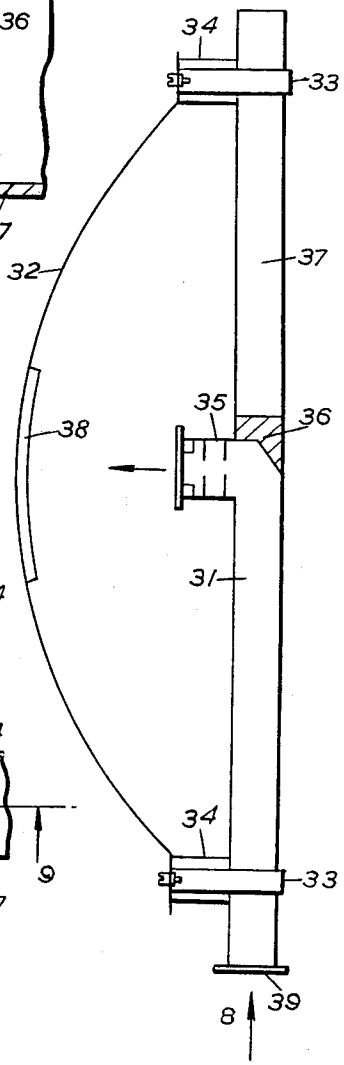


FIG. 8.



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United States Patent Office 2,737,634 Patented Mar. 6, 1956

2,737,634

WAVEGUIDE ELBOW

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Application January 3, 1952, Serial No. 264,734

Claims priority, application Great Britain January 12, 1951

2 Claims. (Cl. 333—98)

The present invention relates to electro-magnetic wave guides, and particularly concerns means for compensating the effects of discontinuities in wave guides.

It is well known that discontinuities produce reflected waves which may seriously interfere with the operation of apparatus connected by wave guides. In particular, it has been found that in super-high frequency radio systems employing frequency modulation, in which a wave guide is used for the connection between the antenna and the transmitting or receiving apparatus, reflected waves may tend to produce a spurious frequency modulation, and very good matching is therefore necessary in the wave guide.

It is, of course, well known to provide diaphragms, windows, stubs, and the like, at suitable points in the wave guide for compensating or tuning out the effects of discontinuities. Hitherto the problem has arisen substantially only at one frequency, since the signal band width is small compared with the super-high frequency used for the carrier wave, and so single frequency compensation is sufficient.

Since a discontinuity is generally equivalent to the effect of connecting a reactance somewhere in the guide, the usual practice has been to neutralise the reactance with one of opposite sign, by providing a stub, or diaphragm, or the like, in the guide. This is equivalent to "tuning out" the discontinuity, but the compensation is only effective in the immediate neighbourhood of one frequency.

Recently the requirement has arisen for radio systems to operate over a relatively wide band of super-high frequencies. One reason for this is that a super-high frequency channel may be allotted any frequency over a relatively wide band, and the frequency might be changed later. Another reason is that several super-high frequency channels may be required.

Thus the need for equipment to operate over any part of a relatively wide band without modification, is becoming evident.

Thus, compensation methods involving simple "tuning out" are in many cases inadequate to the present needs, and other methods of compensating over a relatively wide frequency band are necessary.

The present invention concerns wide band compensation means which deals mainly with discontinuities which are not too large, and will also be applicable as a final adjustment for dealing with the residuals left after the larger discontinuities have been dealt with.

It is based on the following consideration.

A small discontinuity in a wave-guide system usually produces the effect of connecting a small reactive element at some point in the guide, and this element can be a series or a shunt inductor, or a series or a shunt capacitor, or of connecting a combination of an inductor and a capacitor. The effect of connecting a small inductor in series with the guide is substantially equivalent to inserting a small negative capacitance of appropriate value in shunt with the guide, and likewise the effect of connecting a small capacitor in series with the guide is substantially

equivalent to inserting a small negative inductance of appropriate value in shunt with the guide; and vice-versa. Thus for each discontinuity a point can be found where a negative reactive element effectively acts, and the discontinuity can be substantially removed by connecting at the said point an equal positive reactive element which neutralises the negative element, and the compensation is substantially independent of frequency. In the inverse sense, also, when a discontinuity occurs, or has to be introduced for some special reason, which is effectively equivalent to an inductor or a capacitor connected in series or in shunt with the guide at some point the discontinuity can be compensated over a wide frequency band by producing by suitable means the effect of a neutralising negative element at the said point.

Measurements of voltage standing wave ratio over the frequency band concerned, by conventional methods, enable the point in the guide to be found, where a negative element corresponding to a discontinuity effectively operates, and also the magnitude of the element.

It has now been recognised that the provision of a diaphragm at the junction of a straight with a tapered portion of the guide is one particular application of the principles of the present invention. This application is also disclosed in the article entitled "Reflection cancellation in waveguides" by L. Lewin in the "Wireless Engineer" August 1949. In neither of these cases is the principle regarding negative elements pointed out. Accordingly we do not in the present specification intend to claim the application of the principles to the compensation of the discontinuity produced at the junction between a straight and a tapered portion of a waveguide.

It is desirable that a clear distinction should be made between a negative reactance or susceptance and a negative reactive or susceptive element. As is well known, a negative reactance can be produced by a positive capacitance element which is producible by a real element, namely a capacitor. A negative reactance can also be produced by a negative inductance which however is not producible by a real element, though as has already been explained above, the effect of a small negative inductance can be produced by a suitably located real element. Likewise, a negative susceptance can be produced either by a real capacitor, or by an unrealisable negative capacitor.

The present invention provides a waveguide transmission system having a discontinuity from which wave reflections are produced, the effect of which discontinuity is substantially equivalent to the insertion in the otherwise reflectionless guide at a given point of a small reactive element, comprising means for effectively providing at the said given point a reactive element of the same type and magnitude as the said small reactive element but of opposite sign for compensating the effect of the discontinuity over a relatively wide frequency band.

The invention will be described with reference to the accompanying drawings in which—

Figs. 1 and 2 show an H-type corner according to the invention: Fig. 2 is a view looking towards one open end of the corner, and Fig. 1 shows a section at **1—1** of Fig. 2;

Fig. 3 shows curves used in explaining the operation of Figs. 1 and 2.

Figs. 4 and 5 show an E-type corner, according to the invention: Fig. 5 is a view looking towards one open end of the corner, and Fig. 4 shows a section at **4—4** of Fig. 5;

Figs. 6 and 7 show sectional views of a pressure seal for a waveguide according to the invention, Fig. 6 is a sectional view at **6—6** of Fig. 7, and Fig. 7 is a sectional view at **7—7** of Fig. 6;

Fig. 8 shows diagrammatically a waveguide antenna system according to the invention; and

Figs. 9 and 10 show part of Fig. 8 in detail; Fig. 10 is a view looking towards the horn termination of the waveguide, and Fig. 9 is a section taken at 9—9 of Fig. 10.

The basis of the invention will be explained as follows. Suppose a small discontinuity is present at some point in a waveguide. This discontinuity will generally appear as though a small reactive element had been connected to the guide at that point. Suppose it corresponds to a small series inductance L. Then the impedance Z which is presented at the discontinuity is $Z_0+j\omega L$, where Z_0 is the characteristic impedance of the guide and ω is 2π times the frequency.

The corresponding admittance will be given by

$$Y=1/Z=\frac{1}{Z_0+j\omega L}=Y_0-j\omega LY_0^2$$

approximately, where $Y_0=1/Z_0$, if ωL is small compared with Z_0. The susceptance term can thus be considered to be due to a small negative capacitance LY_0^2 which is connected in shunt to the guide. This can be neutralised completely by shunting the guide with a positive capacitance equal to LY_0^2, and the neutralisation is independent of frequency. Likewise a discontinuity corresponding to a small shunt capacitance appears like a series negative inductance, and could be compensated by an equal positive inductance connected in series with the guide.

Certain embodiments of the invention concern the corner elements where two waveguides meet at an angle. The waveguides will be assumed to be of rectangular cross-section, the larger dimension being designated *a* and the smaller dimension *b*. A corner consists of two short sections of waveguide meeting at an angle, usually, but not necessarily, a right angle. Two types of corner will be considered, namely H-type corners and E-type corners. In an H-type corner, the sides of the guide having the larger dimension *a* are in the same plane, while the sides having the smaller dimension *b* meet at an angle. In this type the magnetic lines of force of the electromagnetic field, which are parallel to the larger dimension *a* of the guides are turned through an angle in going round the corner. In an E-type corner, the sides with the smaller dimension *b* remain in the same plane, while the other sides meet at an angle. In this case the electric lines of force of the field, which terminate on the sides having the larger dimension *a*, are turned through an angle in going round the corner.

Fig. 1 shows a sectional view of an H-type corner according to the invention, and Fig. 2 shows the view looking towards the lower open end of the corner. Two short sections 1, 2 of rectangular guide meet at a right-angle, and the outer angle is chamfered off at 45°, and closed with a plate 3 soldered over the opening. The open ends of the guide sections are provided with flanges 4, 5 having bolt holes 6 by which the sections may be bolted to other lengths of guide (not shown).

It is, of course, well known to slice off the angle of a corner in order to reduce the discontinuity produced by the bend. In practice, a terminating guide section (not shown), having an impedance equal to the characteristic impedance of the guide, is bolted on to the flange 5, and measurements of voltage standing wave ratio are made at the mouth of the flange 4. The idea is, of course, to obtain a standing wave ratio as closely equal to 1 as possible, but it is found that this can only be done at a single frequency, values less than 1 being obtained at other frequencies.

A curve of standing wave ratio with respect to wave length as shown in Fig. 3 for this condition. Curve A represents the results obtained for a typical case. Adjustment of the depth of cut of the angle shifts the maximum of the curve A parallel to the axis of wavelengths, and it is usual to adjust this maximum to occur at the mean wavelength λ_m for which the waveguide will be used. It can be seen however, that the standing wave ratio rapidly

decreases on either side of λ_m, and the values at the ends λ_1 and λ_2 of the band are generally too poor for operation at these wavelengths.

This is remedied according to the invention in the following manner:

From measurements of the standing wave ratio at various frequencies at one open end of the corner when the other end is correctly terminated, it can be shown that the residual discontinuity is equivalent to the effect of connecting in series with the guide at the angle 7 a series resonant circuit consisting of a small capacitor and a small inductor. These are equivalent in effect to a parallel resonant circuit of negative elements connected in shunt to the guide at the angle 7.

In accordance with the principles explained above, a compensating positive inductance and a compensating positive capacitance are provided in shunt at this point. One way of doing this is to insert a diaphragm 8 projecting into the guide normally from the centre of the plate 3, that is, in the plane of symmetry of the corner, and a screw 9 which projects into the guide through one of the sides having the larger dimension *a*. The screw should be on a straight line joining the corner 7 to the centre of the plate 3, and should be centred half way between the corner 7 and the edge of the diaphragm 8. The diaphragm 8 provides the compensating inductance, and the amount of projection should be proportioned so that the inductance introduced in shunt across the guide is equal to the equivalent negative inductance introduced by the corner. The screw 9 introduces the compensating shunt capacitance, and should be adjusted to neutralise the negative capacitance introduced by the corner.

The diaphragm 8 could, if desired, be inserted from the angle 7, but the position of this angle is in practice rather ill defined, so that the amount of projection of the diaphragm is more difficult to fix.

According to a variation of this arrangement, the diaphragm 8 may be omitted, and the requisite amount of shunt inductance may be provided by increasing the depth of the outer angle. This may be done so that the total negative inductance effectively introduced at the corner in shunt with the guide is just reduced to zero. The screw 9 should be located in this case half way between the corner 7 and the plate 3, and will be adjusted, as before, to compensate the negative capacitance.

In a particular case in which the dimensions *a* and *b* of the guide were 2 inches and ⅔ inch, respectively, the screw 9 was a No. OBA screw, and compensation was obtained when the outer angle was cut off so that the distance of the plate 3 from the angle 7 was 1.7 inch, for a range of wavelengths from 7 to 8.4 cm. In this case, the final curve of standing wave ratio is shown by curve B of Fig. 3, which is within the limits about 0.97 and 0.99 over this range of wavelengths.

It will be evident that if only the negative capacitance which effectively acts in shunt at the angle 7 of the H-type corner is neutralised by the screw 9 (Figs. 1 and 2), the residual negative inductance also acting at the angle 7 is equivalent to connecting a small capacitor in series with the guide. This may be a convenient method of providing a series capacitance without producing any leakage of the waves, which often occurs when a series capacitance is introduced in the usual way. Obviously, also, if only the shunt negative inductance is neutralized, the effect of connecting a small inductor in series with the guide is produced.

Figs. 4 and 5 illustrate the application of the principles of the invention to an E-type corner, but for a different reason. It is found that when the outer angle is chamfered according to known practice, in order to produce a maximum standing wave ratio at the midband frequency, the variation of standing wave ratio over the whole band is already sufficiently small to be acceptable if the band is not too wide. However, although the proper dimension of cut can be easily determined, rather narrow limits may

have to be imposed, so that in practice, owing to manufacturing variations, it is difficult to ensure that all samples of the corner which are produced will meet the electrical requirements.

According to the present invention, the depth of the chamfer is so chosen that effectively there appears in shunt with the guide a small negative capacitance, and this is then neutralized by an adjustable positive capacitance provided by a screw as in Figs. 1 and 2.

Thus, as shown in Figs. 4 and 5, the E-type corner comprises two short waveguide sections **10** and **11** provided with flanges **12** and **13** with fixing holes **14**, similar to corresponding elements of Figs. 1 and 2, except that the bend is in the plane of the sides having the smaller dimension *b*. The outer angle is cut off and closed by a plate **15** through which projects a screw **16** centred along the central bisecting line of the angle.

The perpendicular distance *d* between the plate **15** and the inner angle **17** is made slightly larger than the distance which would be chosen, in the absence of the screw **16**, to obtain maximum standing wave ratio at the centre of the frequency band for which the corner is designed. A small increase in the dimension *d* is substantially equivalent to connecting in shunt with the guide at the corner, a small negative capacitance which may then be neutralised by suitable adjustment of the screw **16**, which provides a positive capacitance at the corner.

Owing to manufacturing variations, the effective shunt negative capacitance will vary over a small range, and provided that the increase in *d* is sufficient to cover the variations, the screw **16** can always be adjusted to produce the desired result.

In practice, the E-type corner, when accurately made, matches, the waveguide very closely, but slight changes in *d* produce a substantially uniform mismatch over the whole frequency band. By making *d* slightly too large, the screw **16** can always be adjusted to restore the close match over the whole band.

In a particular case in which the waveguide dimensions and range of wavelengths were the same as stated above, the dimension *d* in the absence of the screw was 0.547 inch, which had to be accurate to one or two thousandths of an inch to meet the electrical requirements.

This was found to be very difficult to maintain during manufacture, and so *d* was increased to 0.57 inch, and a No. OBA screw **16** was provided. In this case the limits for *d* could be widened to ± 0.01 inch, and all corners could then be adjusted by means of the screw to fulfill the electrical requirements.

It will be understood, of course, that it is not essential to construct the corners exactly in the manner indicated in Figs. 1, 2, 4 and 5. These figures do not purport to indicate details of construction. Thus for example, it is not essential to cut off the outer angle and close the opening with a plate. Instead, the whole corner might have been cast so as to have the necessary internal shape. Thus when it is stated that the outer angle is "chamfered off" we mean that the corner has the internal configuration indicated in Figs. 1 and 2 or 4 and 5.

The screws **9** and **16** should preferably be provided with lock-nuts (not shown), and it is desirable that after the adjustment has been made, the screws should be sealed to prevent subsequent movement.

Another application of the principles of the invention is illustrated in Figs. 6 and 7. It is often required to seal off a section of waveguide to enable part of it to be exhausted, or filled with a suitable inert gas. In order to do this, it has been the practice to clamp and cement between two sections of guide a thin sheet of insulating material, such as mica, which is transparent to the electromagnetic waves. On account of the fact that the dielectric constant of all suitable transparent material is rather large, an appreciable reflection is produced by the mica sheet. The effect of the mica window is to shunt a small capacitance across the guide. According to the principles explained

above, this capacitance behaves substantially as though a small negative inductance had been connected in series between the two sections of guide. This can be neutralised by connecting an equal positive inductance at that point.

In Fig. 6, a section is shown of the junction of two waveguide sections **18**, **19** which have been shown cut off short, indicating that they can be of any length. Between these sections a sheet **20** of transparent material, such as mica, is clamped. The thickness of this sheet has been exaggerated for clearness. The flanges **21**, **22** at the junction have been modified and enlarged in order to provide a hollow cavity **23** which surrounds the guide in the form of a rectangular annulus. The outer rims of the two guide sections **21** and **22** are clamped on to a metal annular shim **24** (which should preferably be very slightly thinner than the mica sheet **20**), by means of screwed bolts and nuts **25**, **26** passed through holes **27** in the rims of the flanges. The whole will thereby be tightly clamped together, and the mica sheet **20** will be firmly held.

Fig. 7 shows a transverse section of the flange **22**. The internal section **28** of the waveguide is surrounded by a channel **29** in the form of a rectangular annulus. This channel forms one wall of the cavity **23** (Fig. 6). The other wall is formed by an exactly similar channel in the flange **21**. The shim **24** will have a section like that of the outer rim **30** of the flange.

The waves in the guide leak through the slot occupied by the mica sheet into the cavity **23**, which should be designed to act like a small inductance connected in series with guide. According to the principles of the invention, this cavity is so dimensioned that the corresponding inductance is equal to the equivalent series negative inductance introduced by the mica sheet **20**. As already explained, the compensation of the discontinuity caused by the mica sheet is independent of frequency.

The capacitance between the butt ends of the guide sections where the mica sheet **20** is clamped may be appreciable, and if so should preferably be reduced, for example by introducing annular shims of insulating material of low dielectric constant, one on either side of the mica sheet.

It is of course not essential that the cavity **23** should extend completely round the circumference of the guide. In other words the channel **29** might be interrupted at one or more points, thereby producing one or more separate cavities, each communicating with the guide through the edge of the mica sheet **20**.

While it is convenient to provide the compensating cavity in the form of a hollow space enclosed between the two flanges, it could be introduced in other ways. For example, a small separate chamber (not shown) could be provided in any convenient form, communicating with the guide through a section of the slot occupied by the mica sheet.

The principles of the invention may also be applied to improving the matching of the feeder arrangements of a parabolic mirror antenna for a super-high frequency transmitter or receiver. In such a system there are a number of discontinuities producing reflected waves, and each of these may be individually tuned out by suitable means. As these compensations are effected at the mid-band frequency, the standing wave ratio over a wide band may not be sufficiently good. It may however be greatly improved by the neutralisation of negative elements according to the invention.

Fig. 8 shows in diagrammatic form the arrangements for feeding a parabolic mirror antenna, for a super-high frequency transmitter.

A length of rectangular waveguide **31** is clamped diametrically across the mouth of a parabolic mirror **32** by means of clamps **33** and spacers **34**. The larger dimension *a* of the guide is in the plane of the paper. At the centre of the guide there is connected a short length **35** of guide which is tapered as regards the smaller dimension *b* to

form a horn mouth presented to the mirror and located in the focal plane thereof. The taper is of course not visible in Fig. 8. An H-type corner is formed by means of a block **36** which is inserted into the guide **31**, and which blocks off the upper part **37** of the guide **31**, which thus becomes a dummy, and is only retained for mechanical reasons.

The mirror **32** is provided with a vertex matching plate **38** for compensating the mis-match caused by radiation reflected back into the horn **35** from the mirror. Other matching details are indicated in Fig. 8, but will be described in more detail later. The lower end **39** of the guide **31** will be connected to the radio transmitter or receiver (not shown).

It has already been explained that an H-type corner includes the equivalent of shunt elements forming a parallel resonant circuit. The discontinuity which remains after all the several discontinuities referred to above have been compensated at the mid-band frequency can be shown to be approximately equivalent to a parallel resonant circuit of positive elements at some point in the guide, and the length of the guide **35** is therefore chosen so that the point where these positive elements effectively act is at the angle of the H-type corner. The latter is then designed to introduce just the right amount of shunt negative inductance and negative capacitance to neutralize the positive elements. It is then found that the standing wave ratio over the frequency band in question has been improved.

Fig. 9 shows in a sectional view the details of the horn **35** and its connection through the H-type corner to the guide **31**. Fig. 10 shows a view looking into the open end of the horn **35**. The H-type corner is completed by the block **36** which fills up the whole cross section of the guide, and comprises a sloping face **40** set at 45°, and corresponding to the plate **3** of Fig. 1. This face **40** can be seen through the open end of the horn, as indicated in Fig. 10.

The smaller dimension *b* of the guide **35** increases by about 50% from the plane **41** (Fig. 9) to the mouth of the horn, by a straight taper. The larger dimension *a*, however remains constant, as indicated in Fig. 9.

The mouth of horn terminates in a flange **42** across which clamped a mica sheet **43** by an escutcheon plate **44**. The ends but not the sides of the opening in the escutcheon plate are bevelled off, as indicated at **45** and **46**. The mica sheet is provided as a waterproof covering to seal off the waveguide from the atmosphere.

In the plane **41** is placed a diaphragm comprising two metal strips **47** and **48**. These strips project equally into the guide from opposite sides, and their length is such that they extend wholly across the smaller or *b* dimension of the cross-section of the guide. This diaphragm is provided to neutralise the discontinuity at the commencement of the taper.

Some distance in front of the elements **47** and **48** is a window **49** (that is, a plate which fills the cross-section of the guide, and has a suitably dimensioned rectangular aperture cut therein). The window **49** is shown shaded in Fig. 10 for clearness. Parts of the strips **47** and **48** can be seen through this window.

At the mouth of the horn is a very thick diaphragm comprising two metal blocks **50** and **51** arranged in a similar manner to the strips **47** and **48**. These blocks are also visible in Fig. 10. It will be understood, of course, that the diaphragms and window do not necessarily have the relative dimensions indicated by the figures, which have been drawn so that the construction can be most easily understood.

The functions of the parts which have been referred to will now be explained.

The flange **42**, besides acting as a means of supporting the mica sheet **43**, also acts to suppress radiation backwards from the mouth of the horn, according to known practice. The horn mouth has to meet a number of conflicting requirements, and with the comprise adopted has too large an impedance for proper matching to free space, with an appreciable capacitative component which is increased by the presence of the mica sheet **43**. Accordingly, the capacitative component is tuned out at the mid-band frequency by an inductive diaphragm consisting of the blocks **50** and **51**. These blocks are made thick in order to provide a short transmission line of such length as to transform the mouth impedance so that matching at mid-band is substantially effected. It was found that by suitable choice of the cross-section of the metal blocks **50** and **51** the capacitative component could be tuned out and the impedance also matched at the mid-band frequency.

After this compensation has been made, the mouth impedance appears like the characteristic impedance of the guide shunted by a parallel resonant circuit tuned at the mid-band frequency. Some further reduction of the effect of this parallel resonant circuit is obtained by the tuned window **49** set about a quarter of the mid-band wavelength from the mouth of the horn. The dimensions of this window were determined empirically. Compensation is, of course, incomplete over the whole of the frequency band, and there is still left a residual mismatch which, when referred to the corner, has the effect of a parallel resonant circuit connected in shunt to the guide, except in the immediate neighbourhood of the mid-band frequency.

It has already been explained that the diaphragm comprising the metal strips **47** and **48** is placed at this junction between the straight and tapered portion of the guide for compensating over a wide band the effect of the discontinuity at this point. This compensation is substantially independent of any effects due to mis-matching at the horn mouth which are dealt with in the manner just explained.

It has already been pointed out with reference to Fig. 1 that an H-type corner includes the effect of a parallel resonant circuit comprising negative elements. Therefore, according to the principles of the present invention, these elements may be neutralised over a relatively wide band by means of the residual parallel resonant circuit of positive elements which effectively remains after the matching at the horn mouth has been carried out at the mid-band frequency by the expedients described above. It is necessary to choose the distance between the angle of the H-type corner and the throat of the horn in such manner that the positive elements appear effectively at this centre point, and to proportion the distance between the sloping face **40** of the block **36** (Fig. 9) and the inner angle **52** of the corner, and to adjust the screw **54**, accordingly.

By this means, with the dimensions and wavelengths already given, it was found possible to obtain a standing wave ratio of better than 0.96 over the whole band when measured at the open end **39** (Fig. 8).

The relevant dimensions for the above particular case are given below as an example, but it will of course be understood that different dimensions will be required in other cases. The wave band concerned extends from about 7 to 8.4 centimeters.

	Inches
Internal dimensions of guide	2 x ⅘
Internal dimensions of horn mouth	2 x 1
Dimensions of escutcheon plate **44**	2 11/16 x 1½
Cross-section of blocks **50** and **51**:	
Parallel to guide axis	0.325
Perpendicular to guide axis	0.15
Distance of window **49** from front of flange **42**	1.04
Dimensions of aperture in window **49**	1.82 x 0.51
Distance of plane **41** from front of flange **42**.	1.75
Width of strips **47** and **48**	0.136
Distance between front of flange **42** and plane **53**	2.86
Perpendicular distance between angle **52** and face **40**	1.86

As it was found that no capacitance adjustment was required in this particular case, the screw **54** was omitted.

Having regard to the specification of co-pending application No. 5,151/49, and to the article in the Wireless Engineer referred to above, we state that we do not claim in the present specification an electromagnetic wave transmission line arrangement comprising a first hollow waveguide of uniform cross-section joined to a waveguide section in which the cross-section increases uniformly to produce a straight taper, for the purpose of coupling the hollow waveguide to a further wave propagating means, whereby a susceptance is introduced at the junction between the hollow waveguide and the waveguide section by the discontinuity produced by the taper, characterised in this, that an additional susceptance of opposite sign is introduced at the said junction to counteract the first-mentioned susceptance.

While the principles of the invention have been described above in connection with specific embodiments, and particular modifications thereof, it is to be clearly understood that this description is made only by way of example and not as a limitation on the scope of the invention.

What we claim is:

1. An H-type corner element for a rectangular waveguide intended for operation over a given band of frequencies, the outer angle of the corner being chamfered with respect to the two limbs of the element, the internal perpendicular distance between the inner angle and the inner inclined surface of the chamfer being chosen, whereby a maximum voltage standing wave ratio at a frequency near the centre of the given band is obtained, comprising means for inserting an inductive diaphragm projecting inwardly from a wall of the wave-guide in the plane of symmetry of the guide, said wall being one which is parallel to the electric lines of force of the electromagnetic field in the guide, and means for inserting an adjustable screw through a wall of the corner element on a line bisecting the angle between the two limbs of the corner element, said latter mentioned wall being one on which the electric lines of force terminate, whereby the shunt inductance and the shunt capacitance are equal respectively to the negative shunt inductance and negative shunt capacitance produced by said angle.

2. An H-type corner element according to claim 1 in which the means for inserting the shunt inductance comprises means for further reducing the said perpendicular distance between inner angle and the inclined surface.

References Cited in the file of this patent

UNITED STATES PATENTS

Re. 23,131	Webber	June 28, 1949
2,432,093	Fox	Dec. 9, 1947
2,512,849	Cork	June 27, 1950
2,531,447	Lewis	Nov. 28, 1950
2,563,612	Nebel	Aug. 7, 1951
2,640,877	Miller	June 2, 1953