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MICROWAVE BROADBAND BALUN BETWEEN COAXIAL
LINE AND PARALLEL STRIP LINE
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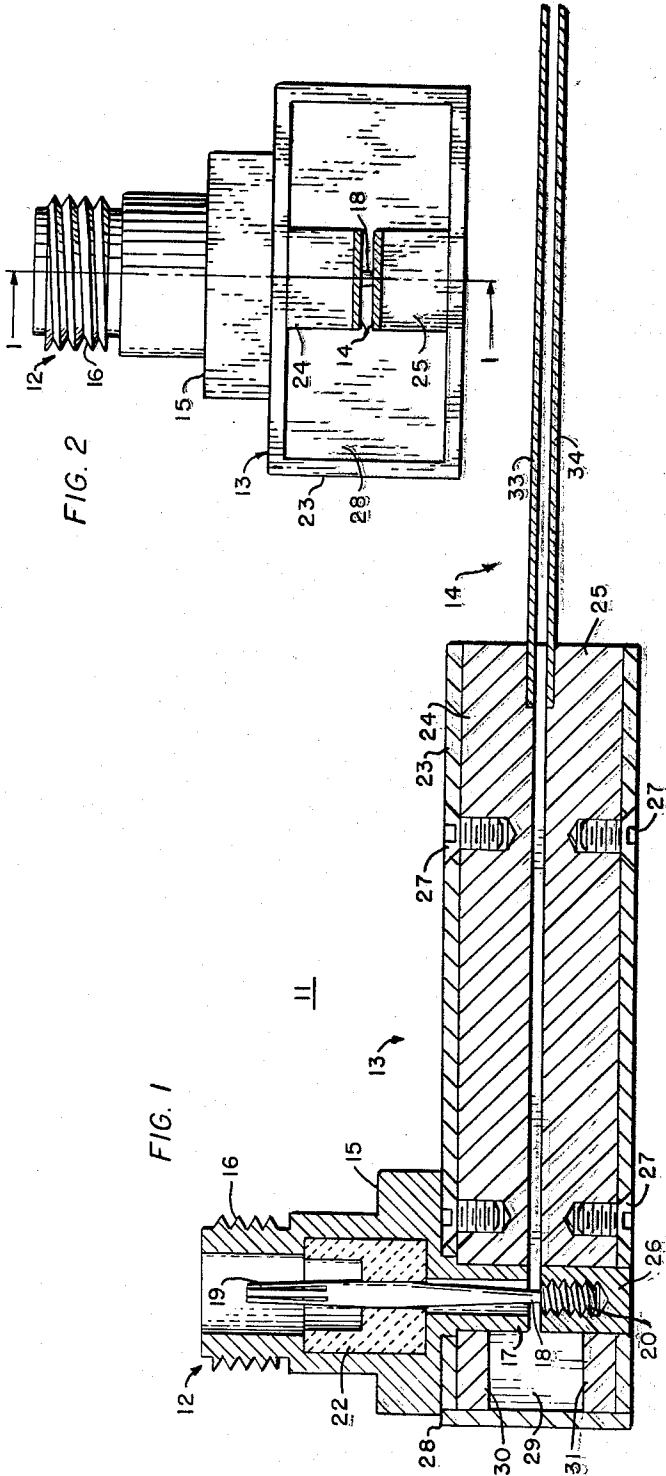


FIG. 1

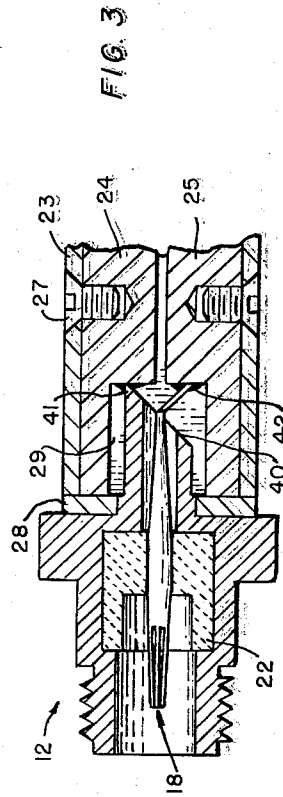


FIG. 3

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MICROWAVE BROADBAND BALUN BETWEEN COAXIAL LINE AND PARALLEL STRIP LINE

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5 Claims. (Cl. 333-26)

(Granted under Title 35, U.S. Code (1952), sec. 266)

The invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment of any royalty thereon.

This invention relates to a radio frequency balun and more particularly to a device which provides a broadband transformation from an unbalanced transmission line to a balanced transmission line or vice versa.

It is sometimes desirable to be able to deliver power to a grounded antenna through a balanced transmission line, or, conversely, to use an unbalanced co-axial transmission line to deliver power to an ungrounded antenna system that is symmetrical with respect to ground. In either case, it is necessary to convert between a balanced system that is symmetrical with respect to ground, and an unbalanced system in which one side is grounded. It is also desirable in such systems that the conversion be as broad-band as possible and that the characteristic impedance level remains constant from one side of the balun to the other.

It is therefore an object of this invention to provide a balun for converting from an unbalanced transmission line to a balanced transmission line.

Another object of this invention is to provide a balun which is relatively broad-band.

Still another object of this invention is to provide a balun which can be designed to maintain a constant level of impedance from the unbalanced line to the balanced line.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings in which like reference numerals designate like parts throughout the figures thereof and wherein:

FIGURE 1 is a sectional view of the invention taken along the line 1—1 of FIGURE 2 and looking in the direction of the arrows.

FIGURE 2 is an end view of the invention.

FIGURE 3 is a view similar to FIGURE 1 but of a modified form of the invention.

Referring now to the drawings, wherein like reference characters designate like or corresponding parts throughout the several views, there is shown in FIGURE 1 (which illustrates a preferred embodiment) a balancing unit (balun) 11 comprising a coaxial connector 12 a transformer element 13 and a balanced transmission line 14.

Connector 12 comprises an outer conductor in the form of a sleeve 15 having at one end screw threads 16 for connection to the outer conductor of a conventional coaxial transmission line (not shown) and at the other end and extension 17 for providing a snug connection to the transformer 13. Extending through sleeve 15 is an inner conductor in the form of a coaxial pin 18 having spring fingers 19 at one end, for connection to the inner conductor of the conventional coaxial transmission line and a threaded head 20, for connection to the transformer 13. Snugly mounted between pin 18 and sleeve 15 is an insulating spacer 22 for insuring a coaxial relationship between pin 18 and sleeve 15.

Transformer 13 is in the form of a rectangular waveguide 23 having upper and lower parallel ridges 24 and

25 respectively connected to the waveguide 23 by screws 27. Waveguide 23 is mounted with its longitudinal axis perpendicular to the longitudinal axis of the connector 12. Openings are provided in the upper wall of waveguide 23 and ridge 24 for reception of the extension 17 which makes a snug electrical connection with ridge 24. A female plug 26 having screw threads for the reception of head 20 is mounted in openings provided in ridge 25 and waveguide 23. Waveguide 23 is closed at one end by a plate 28 to form a quarter wave cavity 29 extending from wall 28 to the plane which includes the longitudinal axis of pin 18. Both ridges 24 and 25 are stepped down to provide ridge sections 30 and 31 respectively in cavity 29 for a purpose which will be later explained. To insure that the desired mode (TE_{10}) is properly established, waveguide 23 should extend at least one wavelength for all operating frequencies of the device, from the connection of pin 18 to ridge 25 to the balanced line 14.

Extending from the end of the waveguide 23 opposite the end containing cavity 29 is a parallel plane transmission line 14 comprising two parallel strips 33 and 34. The strips are secured in grooves provided in the ridges 24 and 25. The distance between these strips is equal to the distance between the ridges 24 and 25 while the width for the strips is equal to the width of the ridges as can be seen in FIGURE 2.

If a coaxial line, transmitting energy in the TEM mode, is attached to connector 12 it will excite a TE_{10} mode in the ridged waveguide 23 in a well known manner. The impedance of waveguide 23 is adjusted to equal the impedance of the coaxial line to prevent any reflections of energy during the transition. The impedance of waveguide 23 will depend on the geometry of the interior of the waveguide. The ridged waveguide is employed as the transformer element since the characteristic impedance of this waveguide can be made equal to that of the standard coaxial lines along with increasing the range between the cut off wavelength of the various modes thereby providing a broad-band transition. The ridges are stepped at 30 and 31 so that cavity 29 will present a large or infinite impedance to the transmitted energy. Substantially all of the energy will then be transmitted between the ridges 24 and 25 to the strip lines 33 and 34. A TEM mode will be excited along the strip lines 33 and 34 by waveguide 23. Since the characteristic impedance of the coaxial line, the waveguide and the strip line are all equal there are no losses due to reflections. It can therefore be seen that an efficient broad-band transition has been provided from an unbalanced to a balanced line. Obviously the device will also provide the same transition in the reverse direction, i.e., from balanced line to unbalanced line. It may also be noted that ridges 30 and 31 may also be eliminated thereby providing an even larger impedance than when the ridges are stepped.

The modified version shown in FIG. 3, which also operates in the same manner as the device of FIG. 1, may be used where an axial connection between the transformer 13 and the coaxial waveguide is desirable. In the modified form the outer extension 17 is tapered as at 40 to provide a connection 41 between the extension 17 and ridge 24. The pin 18 is bent away from the longitudinal axis of the connector 12 and connected at 42 to ridge 25. Both connections 41 and 42 may be provided by soldering the elements together. Extension 17 extends through an opening in the center of the plate 28.

Obviously many other modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within

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the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. A balun for providing a broad-band transition from an unbalanced transmission line to a balanced transmission line, comprising a double-ridged rectangular waveguide, means for connecting at a first location said unbalanced transmission line to said ridges, means connecting at a second location said balanced transmission line to said ridges, said ridges being spaced such that the characteristic impedance of said waveguide at all locations between said first and second locations is equal to the characteristic impedance of said balanced and unbalanced transmission lines, and said first and second locations being spaced a distance of at least one wavelength for all operating frequencies.

2. A balun for providing a broad-band transition from a coaxial line to a two conductor balanced strip line, comprising a double ridge waveguide having upper and lower symmetrical ridges, first means for connecting the outer and inner conductors of said coaxial line to said upper and lower ridges respectively, second means spaced from said first means, at least one wavelength for all

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operating frequencies, along the length of said waveguide, for connecting one of said strips to each of said ridges, and the width of said strips each being equal to the width of said ridges.

3. A balun as described in claim 2 wherein said waveguide further comprising a quarter wave cavity extending from said first means in the direction opposite to that of said second means.

4. A balun as described in claim 2 wherein the longitudinal axis of said coaxial line is oriented at right angles to the longitudinal axis of said waveguide.

5. A balun as described in claim 2 wherein the coaxial line is oriented coaxially with respect to the waveguide.

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