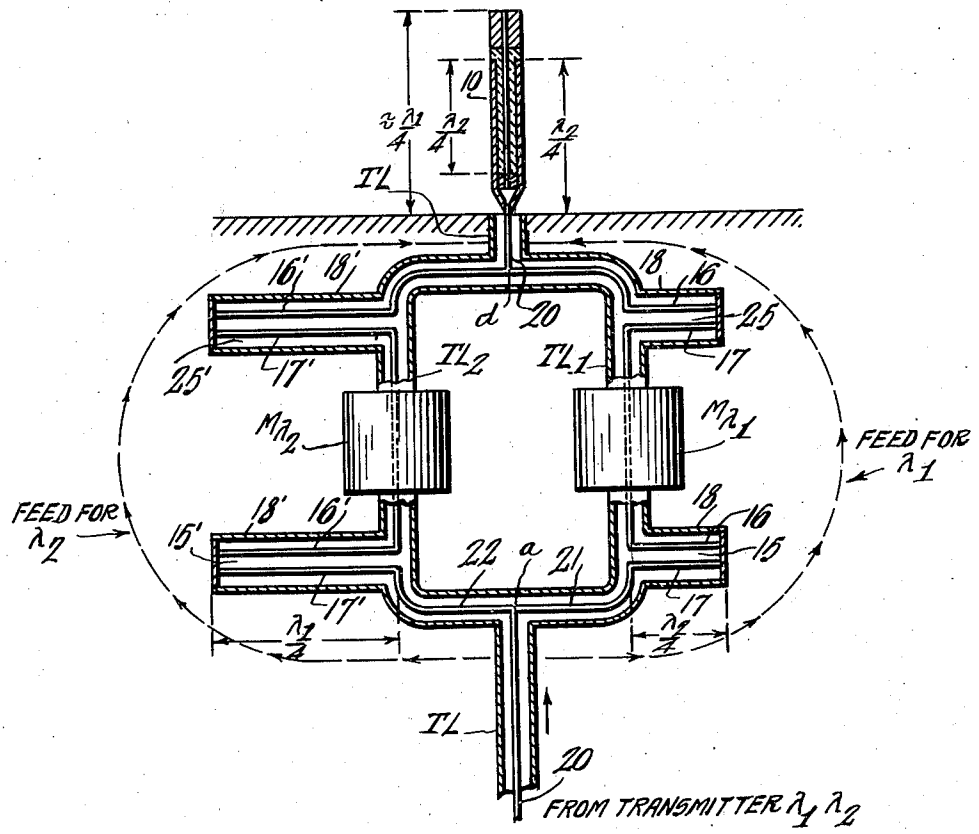
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TRANSMISSION LINE SYSTEM

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TRANSMISSION LINE SYSTEM

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The present invention relates to transmission line systems and, more particularly, to such systems for feeding a single antenna at two widely spaced frequencies.

An object of the present invention is the provision of a novel system for feeding and matching an antenna to a transmission line over two widely spaced frequency bands.

Another object of the present invention is the provision of a system as aforesaid which permits the use of any desired type of matching section in the branches of the circuit.

A further object of the present invention is the provision of a single small antenna for use on two widely spaced frequency bands.

Still a further object of the present invention is the elimination of the necessity for using a plurality of antennas on aircraft.

The foregoing objects and others which may appear from the following detailed description are attained by providing a reentrant branched transmission line circuit from a transmitter capable of operating on a pair of different frequencies to a single antenna. The branches of the transmission line are so arranged that energy of one frequency passes entirely through one branch of the system while energy at the other frequency passes through the other branch. Thus, each branch may contain its own individual impedance matching circuits for matching the antenna to the feed line from the transmitter.

The present invention will be more fully understood by reference to the following description which is accompanied by a drawing in which reference number 10 denotes an antenna which is to be fed by means of transmission line TL with one of two frequencies λ_1 and λ_2 from a transmitter (not shown) Antenna 10, while illustrated as a two-frequency stub antenna of the type described in more detail in my copending application #636,932, filed December 22, 1945, need not necessarily be of this type. A simple stub antenna may be used if desired.

The following description will be generally predicated on the assumption that a simple stub antenna is used. Any one interested in a further elucidation of the principles of operation of the two-frequency stub antenna is referred to the more complete description appearing in the copending application referred to above.

The transmission line TL contains a pair of reentrant branches TL_1 and TL_2 connected in parallel relationship between points a and d. The inner conductor 20 splits into conductors 21 and 22 at point a and then again comes together in a single conductor at point d. Branch TL_1 contains a short-circuited series line section 15, having a pair of parallel inner conductors 16 and 17, each a quarter wave long at the frequency λ_2 which is the frequency adapted to be passed

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through the other branch of the network. Conductors 16 and 17 are connected together and to the outer shell 18 of the line section 15 at one end and connected in series with the inner conductor 21 of transmission line TL at their other ends. Conductor 21 then passes through an impedance matching section $M\lambda_1$ designed to match the impedance looking out of the matching section 15 to the impedance at the input of a second series line section 25 at the frequency λ_1. The second short-circuited series line section 25, likewise having short-circuited quarter wave inner conductors 16 and 17 and an outer casing 18 identical in dimensions and arrangement to the short-circuited series line section 15, follows the matching section $M\lambda_1$. From the second series section the transmission line TL_1 again enters the main transmission line TL at point d and proceeds to the antenna 10. Branch TL_2 has the same reference numerals as applied to branch TL_1 but primed in order to indicate that the construction is generally similar but the actual dimensions are different. That is, the short-circuited series line sections 15' and 25' are designed to present high impedance at frequencies which are adapted to be passed by the line TL_1. The matching section $M\lambda_2$ is designed to match the impedance looking out of short-circuited line section 15' into the short-circuited series of line section 25'.

In considering a signal of wavelength λ_1 approaching the junction at (a) from the direction of the transmitter, the signal will take the right-hand branch at (a) into transmission line section TL_1 for the following reasons:

Looking into TL_2 from (a) is seen a very high impedance due to line section 15', which, being shorted at its far end and one quarter wavelength long at λ_1, presents a very high impedance in the direction from (a) to 15'.

Looking into the right-hand branch TL_2 is seen a matched impedance of the system

$$a—15—M\lambda_1—25—d$$

since the matching section $M\lambda_1$ is designed to match the impedance of the entire system beyond the matching section to the system consisting of the line section 15 in series with the transmission line TL leading from the transmitter. The transmitter is of course assumed to be matched to the main transmission line TL.

Therefore, all or almost all of the current entering the junction (a) at the wavelength λ_1 takes the right-hand branch passing in turn through the line section 15, through the matching section $M\lambda_1$, through the line section 25, through the junction (d) at the base of the antenna and into the antenna 10. At the junction (d) almost all of the current passes into the antenna since there is a very high impedance look-

ing in the direction from (*d*) to the line section **25'**, this line section being identical with line section **15'** and presenting a very high impedance to energy at a wavelength λ_1 thereby preventing circulating current in the branch circuit.

In similar manner it is evident that at the wavelength λ_2 all or almost all of the current will go through transmission line TL_2 to the antenna **10**, the line sections **15** and **25** being shorted quarter wave lines at this wavelength and consequently presenting high impedance at the junctions (*a*) and (*d*).

Further, this system has compensating features which result in wider pass band in the vicinity of the two wavelengths λ_1 and λ_2 than are obtainable with heretofore used methods. Suppose, for example, that the antenna is a conventional series stub antenna, it will present a capacitive reactance to the transmission line at frequencies below resonance and an inductive reactance at frequencies above resonance. At the wavelength λ_1 the antenna is fed through branch TL_1. The line section TL_2 which at this wavelength is less than a quarter wavelength long introduces an inductive reactance in series with the antenna at point (*d*). This inductance tends to cancel the capacitive reactance of the antenna. Thus, it is easier to match the system between matching section $M\lambda_1$ and antenna **10** to the transmission line TL through the matching section $M\lambda_1$. Also matching section $M\lambda_1$ is effective over a broader band of frequencies than would otherwise be possible. Conversely for short wavelength λ_2 at which the antenna is fed through the lefthand branch TL_2, the line section **25** which at this wavelength is more than a quarter wavelength long introduces a capacitive reactance in series with the antenna. This capacitance tends to cancel the inductive reactance of the antenna making the system easier to match by means of matching circuit $M\lambda_2$, making the matching circuit effective over a broader band of frequencies.

Although the present invention has been discussed particularly with reference to an unbalanced antenna and a coaxial line system, it should not be presumed that this method is restricted thereto. The same matching system may of course be equally well used with balanced antennas fed by means of shielded or open-wire two conductor balanced lines.

While I have illustrated a particular embodiment of the present invention, it should be clearly understood that it is not limited thereto since many modifications may be made in the several elements employed and in their arrangement and it is therefore contemplated to cover any such modifications as fall within the spirit and scope of the invention.

What is claimed is:

1. An antenna feed line system for operation at two frequencies including a branched reentrant transmission line from a source of energy at said frequencies to a single antenna, each branch of said transmission line including a first and a second short-circuited series line section, the line sections in each branch presenting a high impedance to a different one of said frequencies, a series matching section interposed between said series line sections in each branch, said matching sections serving to match the impedance of the first of said line sections to the impedance of the second of said line sections and said antenna at the one of said two frequencies to which the line sections in said branch do not present a high impedance.

2. An antenna feed line system for operation at two frequencies including a branched reentrant transmission line from a source of energy at said frequencies to a single antenna, each branch of said transmission line including an inner conductor and outer shell and each branch of said transmission line including a first and a second short-circuited series line section, the line sections in each branch presenting a high impedance to a different one of said frequencies, a series matching section interposed in each branch between said series line sections, said matching sections each serving to match the impedance of the first of said line sections to the impedance of the second of said line sections and said antenna at the other of said two frequencies, said series line sections each including a pair of parallel conductors within an outer shell, said conductors each having a length equal to an odd multiple including unity of a quarter wavelength at the frequency to which it is to present a high impedance, said conductors being connected together and to said shell at one pair of adjacent ends, the other ends being connected in series with the inner conductor of its branch.

3. An antenna feed line system for operation at two frequencies including a branched reentrant transmission line from a source of energy at said frequencies to a single antenna, each branch of said transmission line including means presenting a high impedance to a different one of said frequencies, each branch also including a series matching section, each of said matching sections serving to match the impedances in each branch for the frequency which it is to pass.

4. In an antenna feed line system for operation at two frequencies including a branched reentrant transmission line from a source of energy at said frequencies to a single antenna, said transmission line including an outer shell and inner conductor and each branch of said transmission line including impedance elements presenting a high impedance to one of said frequencies and having a minimum effect on the other of said frequencies, said impedance elements including a pair of parallel conductors within an outer shell, said conductors each having a length equal to an odd multiple including unity of a quarter wavelength at the frequency to which it is to present a high impedance, said conductors being connected together and to said shell at one pair of adjacent ends, the other ends being connected in series with the inner conductor of its branch.

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