June 28, 1949. S. B. PICKLES 2,474,277

TRANSMISSION LINE

Filed March 19, 1945

Fig. 1.

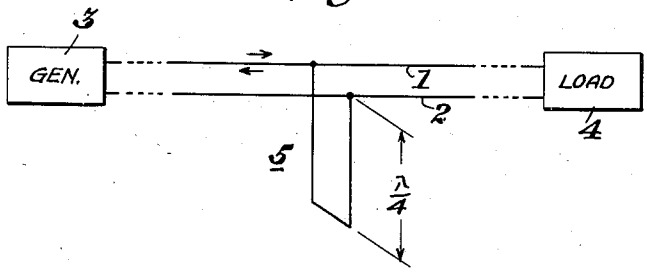


Fig. 2.

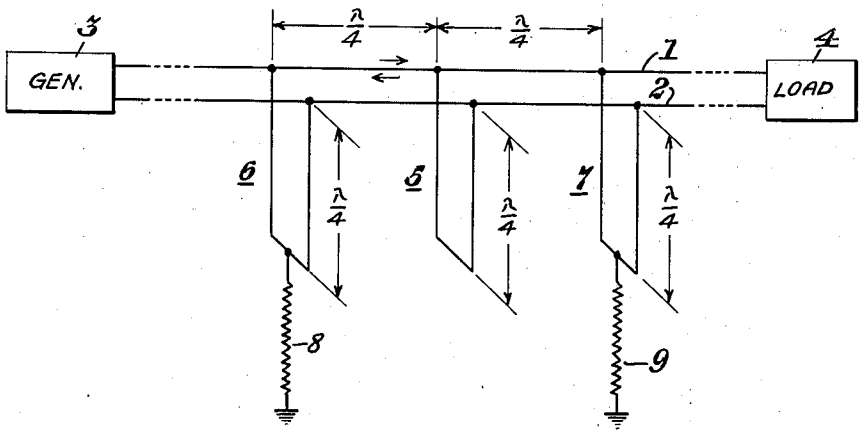
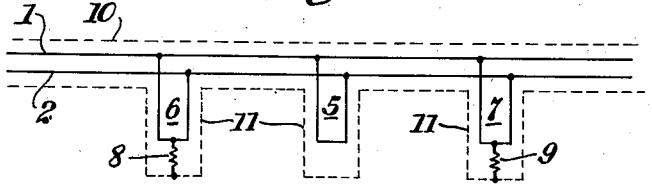


Fig. 3.



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TRANSMISSION LINE

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6 Claims. (Cl. 178—44)

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This invention relates to wave transmission systems and more especially to systems employing balanced transmission lines.

A principal object of the invention is to provide an improved blocking arrangement for preventing unbalanced currents in a normally balanced transmission line, from reacting undesirably on the terminal equipment connected to the line.

Another object is to provide a balanced transmission line coupling section having improved means for preventing unbalanced line currents from setting up undesirable resonance conditions in the line.

Another object is to provide a balanced transmission line with a quarter-wave blocking stub for unbalanced currents, together with means for localizing the effect of the unbalanced currents so that they are dissipated before reacting on the generator or load connected to the line and before they can set up any undesired resonance conditions in the line.

A feature of the invention relates to a novel building-out network employing quarter-wave line sections for blocking unbalanced line currents and for preventing the building-out network from reacting on the generator connected to the line.

Another feature relates to a shielded transmission line designed for balanced current transmission, having a quarter-wave line section connected thereto for blocking out unbalanced currents, and in conjunction with a pair of similar quarter-wave line sections disposed on opposite sides of the blocking section and forming dissipation networks for unbalanced currents on either side of said blocking section.

Another feature relates to a shielded transmission line having a short-circuited quarter-wave line section bridged thereto, and in conjunction with a similar pair of quarter-wave line dissipating sections on either side of the blocking section, said dissipating sections constituting coaxial lines which are terminated in their respective characteristic impedances to prevent undesired resonance conditions which tend to arise from interaction between the blocking section and the generator as a result of said unbalanced currents.

A further feature relates to an improved balanced transmission line having one or more quarter-wave impedance matching stub lines.

Other features and advantages not particularly enumerated will appear from the following detailed descriptions and the appended claims.

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In the drawing which shows certain preferred embodiments,

Fig. 1 is a schematic diagram of a balanced transmission line with a quarter-wave blocking section connected thereto.

Fig. 2 is a schematic diagram of a transmission line embodying principles of the invention.

Fig. 3 is a modification of Fig. 2.

Referring to Fig. 1, there is shown a wave transmission line comprising a pair of conductors 1 and 2 which are supplied with wave energy from a suitable source, such as a high frequency generator 3, for supplying energy to a suitable load device or network 4.

Merely for simplicity, the drawing shows a short section of the transmission line, it being understood that a series of similar sections may be employed. The transmission line is of any well-known balanced type and is connected to generator 3 so that in any given region the currents in the respective conductors 1 and 2 are of opposite phase with respect to ground or with respect to some other suitable base such as a shield which encloses the line.

If in such a system, the generator 3 were at all times in perfect balance and the two line conductors were likewise completely balanced, no unbalanced line current components would exist, or at least their effect would be negligible in setting up undesirable resonance conditions in the line. However, in actual practice, these conditions are not always obtainable, with the result that at one or more regions of the transmission line unbalanced current conditions may exist. These unbalanced currents at such regions may be considered, for purposes of explanation, as flowing through the wires 1 and 2 in phase, or at least not of opposite phase. In order to overcome the undesirable effects of such current conditions it has been known to provide in the region of the line where they exist, a "building-out" stub in the form of a quarter-wave transmission line section 5. In accordance with well-known quarter-wave transmission line theory, such a section acts in the nature of a high impedance looking from the generator.

I have found however, that under certain conditions such a blocking section rather than preventing the setting-up of undesirable resonance conditions, may have the opposite effect. This is probably caused by the fact that the quarter-wave stub section applies to the transmission line an impedance which is very low so far as the unbalanced currents are concerned but this impedance is not effectively a short-circuit. The

existence of this small impedance then tends to react on the generator circuit to tune it, resulting in the setting-up of undesired resonance conditions in the line. The net result is that under such conditions relatively high unbalanced voltages can be produced in the system and in certain cases these high unbalanced voltages present more difficulty than if the blocking section 5 had not been used.

I have further found that these difficulties may be overcome by employing one or more quarter-wave dissipating stub sections on opposite sides of the main blocking section. Such an arrangement is shown in Fig. 2 wherein in addition to the usual short-circuited quarter-wave blocking line section 5 there are provided two additional quarter-wave line sections 6 and 7 preferably located at a distance of a quarter-wave length on each side of the section 5. These supplementary sections 6 and 7 are in accordance with one phase of the invention terminated by impedances 8, 9, which are respectively equal to the surge impedances of the said line sections 6 and 7 acting as a two conductor line for parallel currents. The terminating impedances 8 and 9 may be grounded as shown. From this arrangement, it will be seen that since the blocking section 5 is unterminated, any unbalanced energy in that region of the main transmission line is reflected with a maximum voltage to each of the properly terminated building-out sections 6 and 7. The resistive impedances 8 and 9 of these latter sections therefore, dissipate this reflected energy before it has a chance to set up undesirable resonance conditions in other parts of the system. The sections 6 and 7 are connected on each side of the blocking section 5 in the event that the unbalanced line conditions exist either on the generator side of the section 5 or on the load side of the section 5.

Referring to Fig. 3, there is shown an arrangement similar to that of Fig. 2, but embodied in a transmission line wherein the conductors 1 and 2 are enclosed within a shielding conductor 10. In Fig. 3, the parts corresponding to those of Fig. 2, bear the same designation numerals. In this particular embodiment the two conductors of each of the stub sections 6 and 7 are connected through the respective terminating impedances 8 and 9 to the shield 10. Therefore, the conductors of each stub section act as one conductor of a coaxial line, the other conductor of which is provided by the extension 11 of the shield. The impedances 8 and 9 which are connected to the two elements of the coaxial line stub sections absorb the parallel unbalanced currents which may be created by the presence of the blocking section 5.

Various changes and modifications may be made in the enclosed embodiments without departing from the spirit and scope of the invention.

What is claimed is:

1. In combination, a balanced wave transmission line having a building-out section connected thereto in the form of a quarter-wave short-circuited transmission line section, and at least one other quarter-wave transmission line section connected to said wave balanced transmission line adjacent the first-mentioned section and located an odd number of quarter-wave lengths from said building-out section, the short-circuited end of said other section being connected to a dissipating impedance, the other end of which is connected to a point of neutral potential.

2. In combination, a balanced wave transmission line having a building-out section connected thereto in the form of a quarter-wave short-circuited stub line, and at least one other quarter-wave stub line connected to said transmission line adjacent the first-mentioned stub line, the short-circuited end of said other stub line being connected to a dissipative impedance the other end of which is connected to a point of neutral potential and being located approximately a quarter-wave length from the said first-mentioned stub line.

3. In a wave transmission system, a balanced transmission line, a short-circuited quarter-wave stub line connected to said balanced transmission line to act as a block against unbalanced currents on said line, and a pair of dissipating lines also connected to said transmission line on opposite sides of said stub line, said stub lines being spaced on opposite sides of said first-mentioned stub line approximately a quarter-wave length therefrom, said dissipating lines comprising a short-circuited quarter-wave length section, the short-circuited end of which is connected to a dissipating impedance, the other end of which is connected to the ground.

4. In a wave transmission system, a dual conductor transmission line, a plurality of quarter-wave stub line sections connected to said dual conductors at intervals of approximately one-quarter wave length, a conductive shield for said line, said shield having extensions enclosing said stub lines, the intermediate stub line being unterminated with respect to its corresponding shield extension and the remaining stub lines being terminated to the respective extensions of the shield through respective dissipating impedances.

5. A wave transmission system according to claim 4 in which each of said stub lines is a sort-circuited quarter-wave transmission line section.

6. In a wave transmission system, a balanced transmission line, and means to counteract unbalanced currents on said line which tend to set up undesirable resonant conditions therein, said means comprising a set of three one-quarter wave length short-circuited stub lines each connected to said balanced transmission line at spaced intervals of approximately a quarter-wave length, the central one of said stub lines being unterminated, the short-circuited end of the adjacent stub lines being connected to an impedance having a value equal to the characteristic impedance of the stub line acting as a two-conductor line for parallel currents, the other end of said impedance being connected to a point of neutral potential.

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