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SHORTING BAR FOR CONCENTRIC LINES

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Fig. 1.

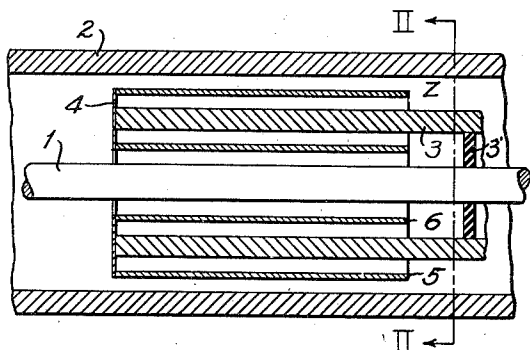
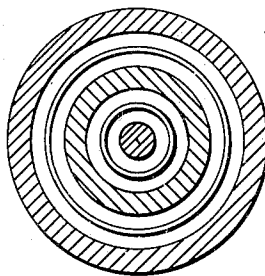


Fig. 2.



WITNESSES:

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SHORTING BAR FOR CONCENTRIC LINES

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3 Claims. (Cl. 178-44)

1

My invention relates to electric transmission lines for high frequency electric currents and, in particular, relates to such lines of the type comprising a central core and a concentric surrounding sheath.

Probably the most useful form of transmission line where electric currents of high frequencies are to be transmitted is the concentric type, and in the general application of such lines to electric circuits, it is frequently desirable to be able to short-circuit the line at some particular point in its length. The problem of short-circuiting transmission lines at ordinary frequencies is a simple one which interposes no difficulty, but in concentric lines operating at ultra high frequencies, difficulties arise which render conventional arrangements for imposing short-circuits undesirable. It is likewise at times desirable to be able to short-circuit such lines for the high frequency currents without imposing a short-circuit for direct current, or even alternating currents of lower frequencies.

One object of my invention is, accordingly, to provide an arrangement for imposing a short-circuit for high frequency electric currents on a selected portion of a concentric transmission line.

Another object of my invention is to provide a method of imposing a short-circuit for high frequency electric currents on a concentric transmission line without short-circuiting the line for direct current or for low frequency alternating currents.

Another object of my invention is to provide a means of imposing a short-circuit for high frequency currents on a concentric transmission line which shall involve no sliding electrical contacts or other sources of irregularity and variable electrical resistance.

Still another object of my invention is to provide a means for short-circuiting a concentric transmission line for high frequency currents in which the effective point of the short-circuit is at one end of a quarter-wave structure employed to effect the short-circuit.

Other objects of my invention will become apparent upon reading the following specification, taken in connection with the drawings in which:

Figure 1 shows a longitudinal section of a concentric-type transmission line provided with a short-circuiting arrangement embodying the principles of my invention; and

Fig. 2 shows a transverse section along the lines II-II in Fig. 1;

The short-circuiting arrangement shown in Figs. 1 and 2 of the drawings depends upon the

2

two following physical principles: First that the input impedance of a transmission line having a length equal to one-quarter of the wave length of the current traversing the line, and terminated in an infinite impedance, is zero. Second that the input impedance of a transmission line having a length equal to one-quarter of the wave length of the current traversing it and which is terminated in a short-circuit is infinite.

These principles are embodied in the arrangement of Fig. 1 in the following way: The line itself comprises a central core 1 of conducting material surrounded and insulated for direct current from a concentric cylindrical sheath of conducting material 2. At the point in this concentric line where it is desirable to impose a short-circuit between the core 1 and the sheath 2 for high frequency electric currents, there is provided an intermediate cylinder of conducting material 3 which is insulatingly supported in any suitable manner from the core 1 such as the annular insulator 3'. Attached to one end of the cylinder 3 is a ring 4 of conducting material which, in turn, supports two cylindrical conductors 5, 6 concentrically with the core 1, the cylinders 5 and 6 having a length equal to one-quarter of the wave-length of the electric current which the transmission line 1, 2 is intended to transmit. The cylinder 3 and the parts just described as attached to it are arranged with any suitable device so that they may be moved back and forth along the core 1 to any desired point. The member 4 is made of thin metal, preferably a negligible fraction of the length of the cylinders 5 and 6.

The annular space between the member 5 and the sheath 2, and the annular space between the core 1 and the cylinder 6, together with these elements themselves, constitute, in effect, electrical transmission lines having a length of one-quarter wave-length. Similarly, the annular space between the cylinders 3 and 5 and between the cylinders 3 and 6 constitute, together with these cylinders, transmission lines likewise of substantially one-quarter wave-length, provided the thickness of the ring 4 is, as above described, a negligible fraction of the length of cylinders 5 and 6. The transmission line just mentioned as existing between the cylinders 3 and 5 is short-circuited at one end by the ring 4 and, in accordance with the second principle mentioned above, it has an infinite impedance at the end remote from ring 4. The infinite impedance just mentioned, together with any stray impedance Z which may exist between the sheath 2 and cylinder 3, is, in effect, connected in series with the

3

above-mentioned quarter-wave transmission line existing between the cylinder 5 and the sheath 2 at one end thereof. In accordance with the first principle above mentioned, the last-mentioned quarter-wave line is, accordingly, terminated at its end adjacent to Z by an infinite impedance, plus the finite impedance Z. Since the sum of an infinite impedance plus a finite impedance is still an infinite impedance, the quarter-wave line between cylinder 5 and the sheath 2 is terminated in an infinite impedance, and by the first principle above mentioned, the impedance at its end adjacent the ring 4 is zero.

By exactly analogous reasoning, the transmission line between the cylinders 3 and 6 is a quarter-wave line short-circuited by the ring 4 at one end and hence having an infinite impedance. The transmission line between the core 1 and the cylinder 6 is, accordingly, in effect a quarter-wave line terminated in an infinite impedance and hence, by the first principle mentioned above, has zero impedance at its end adjacent the ring 4. Since the respective impedances between the ring 4 and the core 1 and that between the ring 4 and the sheath 2 are both zero, the impedance adjacent the ring 4 between the core 1 and the sheath 2 is likewise effectively zero. In other words, a short-circuit for the electrical frequency having a wave length equal to four times the length of the cylinders 5 and 6 exists between the core 1 and sheath 2 at a point adjacent the ring 4.

While I have described a specific embodiment of the principles of my invention, they are of broader applicability in ways which will be evident to those skilled in the art.

I claim as my invention:

1. A short-circuiting device for currents of a frequency to be transmitted on a transmission line of the concentric type comprising a first cylindrical conductor and insulating means for supporting it concentrically with the core of said line, a second cylindrical conductor supported concentrically outside said first cylindrical conductor and connected electrically thereto at one end, and a third cylindrical conductor supported concentrically inside said first cylindrical conductor and connected electrically thereto at the last-mentioned end, the length of said second

4

and third cylindrical conductors being substantially equal to one-quarter of the wave-length corresponding to said frequency.

2. A short-circuiting device for currents of a frequency to be transmitted on a transmission line of the concentric type comprising a first cylindrical conductor and insulating means for supporting it slidably concentrically with the core of said line, a second cylindrical conductor supported concentrically outside said first cylindrical conductor and connected electrically thereto at one end, and a third cylindrical conductor supported concentrically inside said first cylindrical conductor and connected electrically thereto at the last-mentioned end, the length of said second and third cylindrical conductors being substantially equal to one-quarter of the wave-length corresponding to said frequency.

3. In combination with an electrical transmission line for currents of predetermined wave-length of the type having a central core and a surrounding sheath, a first cylindrical conductor and insulating means for supporting it slidably with respect to said core, an annular conductor electrically connected to one end of said first cylindrical conductor, a second cylindrical conductor connected at one end to said annular conductor and surrounding said first cylindrical conductor, and a third cylindrical conductor connected at one end to said annular conductor and positioned inside said first cylindrical conductor, the length of said second and third cylindrical conductors being equal to one-quarter of the wave-length of the current to be transmitted by said line.

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