

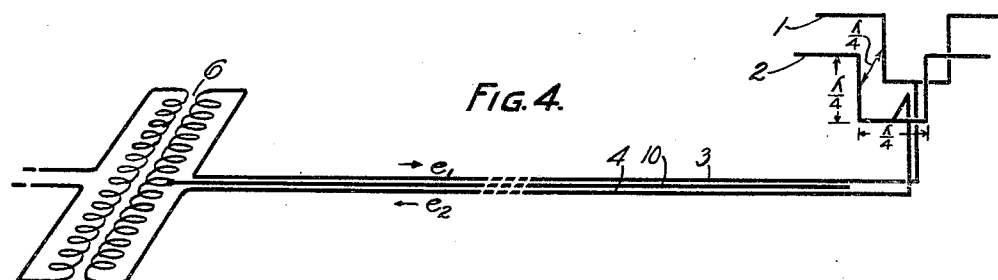
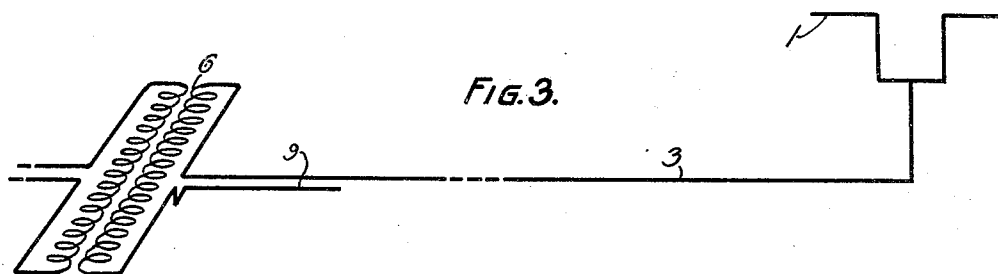
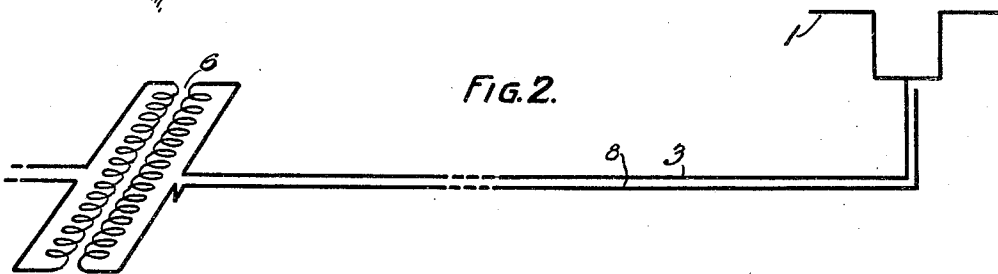
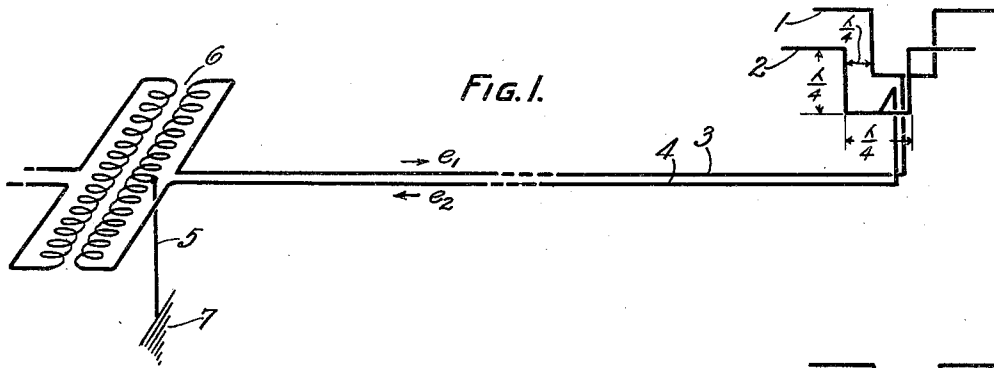
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TRANSMISSION SYSTEM

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TRANSMISSION SYSTEM

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This invention relates to transmission systems and particularly to transmission systems associated with directive antennae.

As is well known, various antenna arrangements having high directional characteristics have been employed in the reception of waves, especially short waves. In these arrangements the maximum directivity for the whole receiving system including the antenna and its transmission line has frequently not been obtained on account of the fact that the directional characteristic of the transmission line has tended to oppose in part that of the antenna proper. Furthermore, in these antenna arrangements the signal current has not assumed its maximum value owing to the relatively high impedance of the transmission line.

It is an object of this invention to transmit the desired aerial current without effecting substantially the directivity of the antenna system proper.

It is another object of this invention to transmit the desired aerial currents without affecting substantially the directivity of adjacent aerial systems.

Another object of this invention is to increase the magnitude of the received signals.

Still another object of this invention is to overcome the effects produced by static and incidental voltages induced in a line.

According to this invention these objects as well as other incidental and related objects are accomplished by the use of a counterpoise conductor located relatively close to and parallel with the transmission line. As used with two-wire lines such as are used in connection with the antenna-reflector system described in my copending application, Serial No. 282,382, filed June 2, 1928, the counterpoise is interposed midway between the transmission conductors which are spaced relatively close together in a horizontal plane.

As pointed out in the above mentioned application, the currents conveyed by these conductors are of opposite phase. The length of the counterpoise is determined by the wave length for which the system is designed and is mathematically equal to the largest odd

multiple of a quarter wave length included in the line.

The invention will be better understood from the following description taken in connection with the drawing, in which:

Fig. 1 represents a center-grounded, balanced, two-wire, transmission line embodying a feature of the invention which tends to reduce the effective reradiation from the line;

Fig. 2 represents an ordinary high frequency single-wire line and associated counterpoise embodying another feature of the invention which tends to improve the directivity of the system as well as to reduce reradiation from the line;

Fig. 3 represents a single-wire line and counterpoise embodying a feature of the invention which serves to increase the magnitude of the incoming signal; and

Fig. 4 represents a combined two-wire line and counterpoise designed to include the features shown in Figs. 1 to 3, together with additional features for carrying out the objects of the invention.

Considering Fig. 1 more specifically, the antenna 1 and reflector 2 comprise elements of a uni-directional aerial system such as is disclosed in my copending application, Serial No. 282,382, filed June 2, 1928. The antenna and reflector conductors 3 and 4, respectively, of the transmission line associated with the aerial system are spaced an equal distance from each other throughout their entire length. They are located as close together as possible, preferably in a horizontal plane, although a spacing of approximately 6 inches has been found sufficiently small to insure the substantial accomplishment of the result sought. Although the conductors are shown as extended in one direction only the line may, of course, assume different directions at various points. Vertical lead 5 connected to ground 7 serves to complete a path for the antenna and reflector currents. A transformer 6 is adapted to transfer energy from the line to the receiver proper. The geometry of the electrical structure is such that the currents flowing in the conductors 3 and 4 are 180° out of phase as specifically pointed out in my copending application

mentioned above. This relationship is indicated by the arrows e_1 and e_2 , which, of course, only represent the directions of the transmitted currents relatively to each other.

5 The manner in which the device of Fig. 1 functions to reduce radiation from the line may be explained as follows:

It is known that radiation intensity varies directly as the amplitude of the current in a transmitting antenna. It follows that the intensity at any point in the field equidistant from two separate radiating systems, such as the antenna and reflector transmission lines, varies as the vector sum of the currents producing the radiation. Since the currents in these lines are 180° out of phase the waves propagated will oppose and consequently tend to cancel each other at all points in space which are equidistant from the lines so that waves originating simultaneously will arrive at the said points at the same time. By locating the wires exceedingly close together this desirable condition may be substantially satisfied at all points in space, therefore insuring negligible radiation interference with aerial systems adjacent to or crossing these lines.

In Fig. 2, the reference numeral 1 represents any ordinary directional antenna and 3 its associated transmission line. This line is connected to a counterpoise 8 through the primary coil of transformer 6. The counterpoise is placed relatively close to the line throughout its entire length.

As mentioned in the brief description of this figure above, the structure shown in Fig. 2 accomplishes two distinct results. That is, by use of a principle analogous to, but having specifically a different application from, that utilized in the system of Fig. 1, a reduction in reradiation is obtained, and furthermore the directivity of the system as a whole is improved. It is well known that radiation intensity in the field of an antenna varies directly as the height of the antenna and as the amplitude of the antenna current. By employing a counterpoise 8 in place of the ground the "height factor" is considerably reduced and consequently reradiation from the line is decreased. Also, by closely spacing the two conductors the voltages induced in the line and counterpoise by incoming waves including static are caused to assume the same phase and, furthermore, by connection of the line 3 and counterpoise 8 in parallel these voltages are caused to oppose and cancel each other; with the result that there is substantially no flow of undesired currents in the primary coil. The directional characteristic of the antenna proper is therefore unaffected by the directional characteristic of the line.

Fig. 3 resembles Fig. 2 in that the elements 65 1, 3 and 6 are the same. Element 9 is a coun-

terpoise having a length equal to an odd multiple of one-quarter of the wave length for which the antenna is designed and uniformly distributed impedance. This counterpoise also differs from that shown in Fig. 2 in that it is not necessarily parallel to the line 3. By providing a counterpoise of this length and character a line of minimum impedance and hence one which permits a maximum incoming current is obtained since in open-ended high frequency transmission lines a conductor such as this counterpoise having a length equal to an odd multiple of a quarter wave length and uniform electrical constants offers a minimum impedance to the current looking toward the open end. If the constants are other than uniform, the desired result may be secured by effecting a compensating change in the counterpoise length. For a detailed discussion of the theory underlying open-ended conductors reference may be had to the Transactions of the A. I. E. E., volume 42, pages 245 to 252.

Fig. 4 illustrates a structure which includes additional features for further reducing radiation and improving the directivity of the aerial system as a whole. As in Fig. 1, 1 and 2 represent a uni-directional antenna-reflector system, 3 and 4 the transmission lines for the antenna and reflector, respectively, and 6 a transformer for transferring the energy to the receiver. As in Fig. 1 the conductors 3 and 4 are uniformly spaced from each other and are relatively close together for the purpose of effecting phase opposition in the propagated waves. The reference numeral 10 identifies a common counterpoise positioned midway between the two lines. This counterpoise has uniformly distributed electrical constants and a length equal to the largest odd multiple of a quarter wave length of the wave traversing the conductors 3 and 4. Such a counterpoise offers a minimum impedance to the transmitted currents and in this respect is similar to that illustrated in Fig. 3. At the same time the counterpoise resembles the one shown in Fig. 2 in that its close spacing from each line throughout most of its length serves to reduce the height factor of each system.

It was pointed out in connection with Fig. 1 that phase opposition in the field was obtained by spacing conductors carrying 180° out of phase currents relatively close together. As a practical matter, however, in the antenna-reflector system shown in Fig. 4 the reflector current is usually smaller than the antenna current on account of the fact that the antenna acts as a screen for the reflector in respect to the desired waves. Because of this, current flows in the counterpoise which is equal to the difference between the antenna and reflector currents and in phase with the smaller or reflector current. All three conductors therefore radiate waves. By posi-

tioning the counterpoise as specified above the reflector conductor and counterpoise in effect become a single wire which, for practical purposes, may be considered to be superimposed on the antenna conductor and therefore induces a field in phase opposition to the field similarly induced by the antenna conductor. Furthermore this single wire may be considered as conveying a current having an amplitude equal to that of the antenna current so that substantial amplitude equality is thus secured by this system with the result that the propagated waves not only oppose each other in phase but also oppose each other with the same amplitude. The resultant field intensity or radiation therefore more closely approximates zero.

Referring to Fig. 2, it was pointed out that a reduction of the height factor resulted in a decrease in radiation. Since the height factor in either radiating system shown in Fig. 4 is not, for obvious reasons, entirely eliminated some radiation dependent in part on the actual necessary height factor will occur from both systems. By placing the counterpoise midway between the conductors the unavoidable height factors in both systems are equalized with the result that the opposing radiations tend to still further balance out each other.

In addition to the advantages already mentioned the structure shown in Fig. 4 possesses the further advantage common also to the system of Fig. 2 in that it tends to improve the directional characteristic of the system. The vertical ground lead shown in Fig. 1 is eliminated and the conductors are spaced as in Fig. 2, exceedingly close together relative to the length of an incoming wave. This arrangement produces a balance between the voltages induced in all three conductors with the result that undesired currents are substantially decreased.

Although only one main embodiment of the invention has been described various features of the invention may be applied in other structures, as for example, in high frequency transmitting systems and in carrier current systems and it is not intended that the application of the invention is to be limited to any specific structure such as the antenna-reflector or simple antenna system.

What is claimed is:

1. In combination with a transmission line, a second transmission line, means comprising an antenna for causing high frequency current to flow in the first mentioned line, and means comprising a reflector for causing high frequency current to flow in the second line, said currents being of relatively opposite phase and the spacing of said lines being small as compared with the wave length of the said current.

2. In combination, an antenna, a reflector, a plurality of high frequency transmission

lines, one of which is connected to said antenna and the other of which is connected to said reflector, said lines conveying currents of opposing phase, and a common counterpoise connected to said lines, said counterpoise being located midway between said lines.

3. In combination, a plurality of transmission lines, means comprising an antenna for causing high frequency currents to flow in one of the said lines, means comprising a reflector for causing high frequency currents to flow in another of said lines, means for causing the phase of the current in the first mentioned line to assume a phase opposite to that in the second mentioned line, an impedance connecting said lines, and a counterpoise conductor connected to the said impedance, said conductor being equally spaced from each of the said lines.

4. In combination, a plurality of transmission lines, means for causing oppositely phased high frequency currents to flow in the lines, a common counterpoise connected through different equal portions of an impedance to the lines, the counterpoise being located equally distant from and parallel to each of the lines and having a length equal to the largest odd multiple included in said lines of a quarter of the mean wave length of the current flowing in the lines.

5. In a high frequency transmission system comprising a plurality of conductors conveying currents of opposing phase connected to a common counterpoise, the method of reducing radiation from the said system which comprises placing the said counterpoise at an equal distance from each of the said lines.

6. In a high frequency transmission system comprising a plurality of conductors conveying currents of opposing phase and different amplitudes connected to a common counterpoise, the said conductors being adjacent to and relatively close to each other, the method of reducing radiation which comprises placing the counterpoise between said conductors and closer to the conductor conveying the smaller current.

In witness whereof, I hereunto subscribe my name this 18th day of March, 1929.

EDMOND BRUCE.