Dec. 31, 1940. A. ALFORD 2,226,687

UNIDIRECTIONAL V-TYPE ANTENNA SYSTEM

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FIG.1.

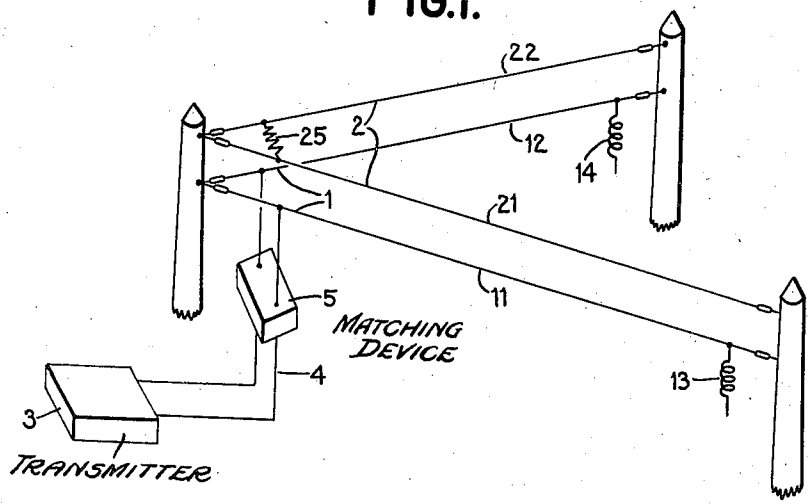
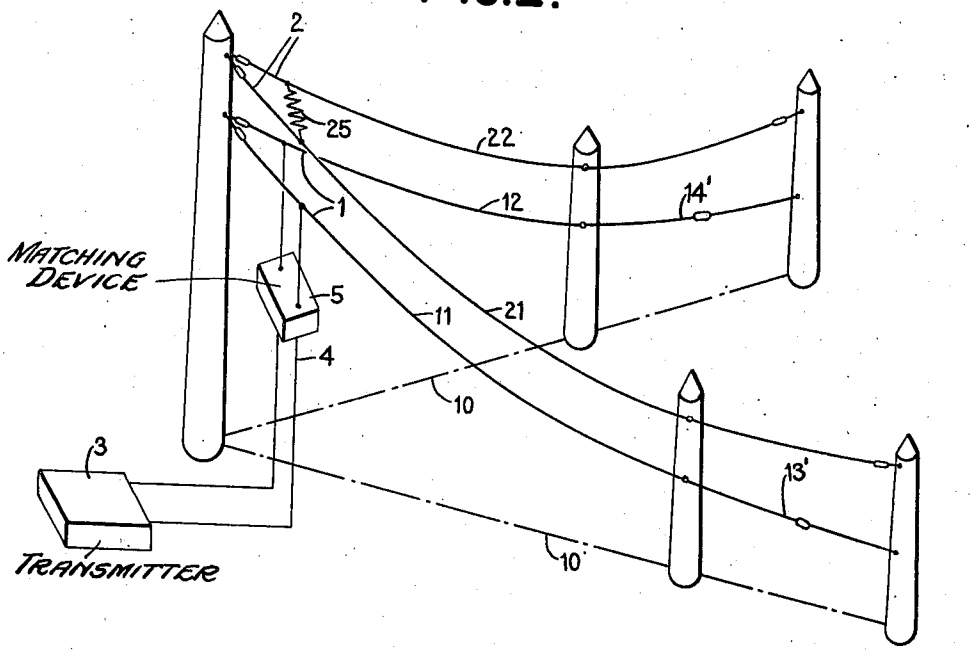


FIG.2.



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UNIDIRECTIONAL V-TYPE ANTENNA SYSTEM

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13 Claims. (Cl. 250—11)

The present invention relates to unidirectional antenna systems and especially to unidirectional antenna systems of the V-type. More particularly the present invention relates to such an antenna system in which a reflecting antenna is provided for rendering the radiant action, i. e. the radiation or reception, unidirectional.

It is an object of the present invention to provide an antenna system, and especially a system of V-antennae which shall exhibit a substantially unidirectional radiant pattern, that is, a radiation or reception pattern, and which shall be simple and inexpensive to erect and efficient in action. More particularly it is an object to provide a V-type antenna system in which the combined action of an exciter antenna and a reflecting antenna serves to substantially eliminate radiant action in the backward direction.

It is a further object to provide such a system which shall be substantially aperiodic.

It is well known that the V-type antenna has many advantages as a producer of directional radiant coupling with the ether, that is, as a radiating or receiving antenna with a directional pattern. Among these advantages are, the simplicity of erection, the small number of poles required for supporting the antenna, and the possibility of nesting two or more such V-antennae within one another to form a compact array. Because of the wide separation of the outer ends of such a V-antenna, however, the problem of eliminating backward radiant action so as to make the radiant pattern unidirectional cannot be readily solved by known methods such as interconnecting these outer ends by a simple resistance so as to prevent the reflection of energy at these outer ends. It has been suggested to employ a plurality of such V-antennae spaced a suitable fraction of a wavelength apart and energized in such phases that backward radiations from the antennae neutralize one another, but such an array is not in general aperiodic.

In my copending application, Ser. No. 18,994, filed April 30, 1935, I have disclosed means for terminating a V-type antenna in a reflection-free manner so as to render the radiant action of this antenna substantially unidirectional. These terminating means may consist of physically short but electrically long artificial lines connected to the ends of the V-type antenna. These condensed artificial lines may preferably take the form of helices or widely spaced solenoids of resistance wire, one end of each solenoid being connected to the open end of the antenna, and the other end being open circuited. If each of these solenoids has a length very great in comparison with its diameter and has a separation of turns comparable with its diameter, I have found that the input impedance of each such solenoid will be substantially a pure resistance and substantially independent of frequency over a wide range, when the far end of the solenoid is not connected to anything but is open circuited. Each of these concentrated solenoidal artificial lines should be of such dimensions and have such resistivity that its total attenuation is very high.

I have found that with the ordinary dimensions which I prefer to employ, the input impedance of each of these open ended concentrated artificial lines is ordinarily considerably higher than the surge impedance of the antenna conductor for the range of waves for which my invention is usually employed. In my Patent 2,159,646 used May 23, 1939, a system is disclosed in which these concentrated artificial lines are connected in pairs or in groups of three to the ends of the antenna conductors so as to terminate these antenna conductors in a substantially reflection-free manner whereby unidirectional action of the antenna is obtained. According to the present invention, one such artificial line may be employed to terminate one antenna conductor.

In one form of the present invention I employ this same type of concentrated highly attenuating artificial line, one such line being connected to the free end of each antenna conductor of the main or exciter V-antenna, and the input impedance of each such concentrated artificial line being considerably higher than the surge impedance of the antenna conductors so that a substantial reflection occurs. I then provide a reflector antenna adjacent the exciter antenna to neutralize the backward radiant action introduced by such reflection, by creating a second backward wave out of phase with but of substantially the same amplitude as and traveling in the same direction and along substantially the same path as the backward wave of said exciter antenna.

My invention can best be understood by reference to the attached sheet of drawing, in which—

Fig. 1 represents a transmitting or receiving system including one exciter antenna and one parasitic reflector antenna both adjacent thereto;

Fig. 2 represents another form of my invention similar to the form disclosed in Fig. 1 but hav-

ing an inclined or sagging antenna whose outer ends are close to the ground, as disclosed in my Patent 2,081,162 issued May 25, 1937.

Referring more particularly to Fig. 1, 1 is a main, directly fed antenna or exciter antenna consisting of two limbs 11 and 12 supported by strain insulators from three poles as shown, and fed at its apex from transmitter 3 through transmission line 4 and impedance matching device 5. At the outer ends of the limbs 11 and 12 are connected the concentrated highly attenuating artificial lines 13 and 14, each of which consists of a long narrow solenoid of resistance wire having widely spaced turns with respect to its diameter, as previously described. Above this exciter antenna 1 the parasitic reflector antenna 2 is supported from the same poles which support the exciter antenna by means of strain insulators as shown. This reflector antenna 2 is disposed directly above antenna 1 and closely adjacent thereto, being preferably separated therefrom by a small percentage of a wavelength, i. e. about 1% to 10%, at the frequency at which the antenna is to be employed. The wavelengths with which this type of antenna system is preferably employed range from a few meters to a few hundred meters. At the apex of reflector 2 the resistor 25 is connected between the limbs 21 and 22, this resistor being preferably equal to the apparent surge impedance of the reflector at this apex point, so that for waves traveling backwardly along the reflector antenna this antenna will be terminated in a reflection-free manner.

The operation of the system shown in Fig. 1 is substantially as follows: Waves are transmitted from transmitter 3 over line 4 and through the matching device 5 to the antenna 1, along which they travel forwardly. Because of the close proximity of limbs 21 and 22 to the limbs 11 and 12 of the principal or exciter antenna, forwardly traveling waves will be induced in the limbs of the reflector antenna. These induced waves will be opposed in phase to the waves traveling in the exciter antenna. Near the apex of the V-system the waves in the exciter antenna will be of full amplitude while the waves in the reflector antenna will be of negligible amplitude. As the waves progress outwardly, however, the amplitude in the limbs of the exciter antenna will decrease both as a result of useful radiation and also as a result of the transfer of energy by induction from the exciter antenna to the parasitic reflector. In the reflector antenna 2, however, the waves will increase in amplitude as the outer ends of the limbs are approached; so that the relative amplitudes of the waves in the exciter and reflector antennae will tend toward equality. It is apparent that if the limbs 11, 21, 12 and 22 were of extremely great length and if the coupling between 11 and 21 and between 12 and 22 were very close, a substantial equality of amplitude would be obtained at the ends of the limbs. Under these conditions the outer portions of the V-system would exhibit practically no net radiant action because the equal and opposite waves in closely adjacent limbs would mutually neutralize radiation. According to the invention, however, the degree of coupling between the limbs of the principal antenna and the limbs of the reflector antenna is so related to the length of these limbs that at the outer end of the V the forwardly traveling waves in the exciter antenna are still considerably larger than the corresponding waves of opposite phase in the reflector antenna; thus throughout the length of the V a considerable forward radiation takes place. In the form shown in Fig. 1, the inductive coupling is produced by both electromagnetic and electrostatic induction with the latter probably predominating. Either type of induction, however, may be used predominantly or solely to effect the inductive coupling.

At the outer end of the V the waves in the exciter antenna are considerably reduced, for example, to sixty percent of their original amplitude, while the waves in the reflector antenna have been built up to an amplitude equal to, for example, thirty percent of the original amplitude in the exciter antenna. For such a 2 to 1 relation of the amplitudes of the waves in the exciter and reflector antennae, respectively, the terminating artificial lines 13 and 14 should be adjusted so that each of these artificial lines has an effective input impedance equal to three times the surge impedance of the antenna conductor to which it is connected. Thus three-fourths of the energy of the arriving waves will be dissipated in the terminating artificial lines and only one-fourth will be reflected. The reflected wave in each of the limbs of the exciter antenna will thus have one-half the amplitude which it had when it reached the outer end of its length, or in other words, will have an amplitude of thirty percent of the original exciter amplitude. The forwardly traveling waves in the reflector antenna, on the other hand, will be reflected with substantially no change in amplitude. Therefore, the backwardly traveling waves in the limbs of the exciter antenna will be equal in amplitude to the corresponding backwardly traveling waves in the limbs of the reflector antenna.

Furthermore, since the reflection from the open ended reflector antenna limbs takes place with a reversal in sign of the current component but no change in the voltage component, and since this same kind of reflection takes place at the ends of the exciter antenna when the impedance of the terminating devices 13 and 14 is purely resistive but greater than the surge impedance of the limbs themselves, the waves in the reflector antenna will still be 180 degrees out of phase with the waves in the exciter antenna after both waves are reflected. Because of the equality in amplitude and the opposition in phase of the waves in the exciter and reflector antennae, respectively, and because of the fact that these two antennae are closely adjacent, substantially no radiation will result from these backwardly traveling waves in the two antennae.

The backwardly traveling waves will not change change in relative amplitude as they return toward the apex of the V since their interactions are mutual and equal, and since there is substantially no radiation. Even if small decreases in amplitude occur by virtue of losses in the antenna conductors, these losses will be substantially equal so that the backward waves will continue to be equal in amplitude until they reach the apex of the V. Finally when the apex is reached the waves in the reflector antenna 2 will be absorbed in resistor 25, while the waves in the exciter antenna 1 will travel down to the matching device 5. Whether these waves are reflected from the matching device 5 or whether they are reflected from the apex of the exciter antenna before traveling down to the matching device 5, these reflected waves may be considered as part of the incoming energy fed to the antenna and can therefore be neglected.

In the above description it was assumed that the relative amplitudes of the waves arriving at the outer ends of the V in the exciter and reflector antennae, respectively, was 2 to 1. This ratio was assumed merely by way of example. If the ratio should have some other value it would be merely necessary to adjust the effective input impedance of the devices 13 and 14 correspondingly in accordance with the known formulae for reflection at a junction. For example, if the forwardly traveling waves in the exciter antenna were three times as great in amplitude as the forwardly traveling waves in the reflector antenna, each of the terminating artificial lines 13 and 14 should be adjusted to have an effective input impedance equal to twice the surge impedance of the conductor to which it is connected.

Fig. 1 of the drawing may also be considered as representing a receiving system, the device 3 being taken as representing a receiving station instead of a transmitting station, and all other parts being essentially the same except for such changes in design as may be found expedient because of the lower power level encountered in receiving. Because of the well known reciprocal relation between any source and any load device in a system made up only of electrically linear component parts, it follows at once that the radiant pattern of the antenna system of Fig. 1 will be the same when used for reception as when used for transmission. In order that the operation of the invention may be more completely understood, however, a brief description will be given of the way in which incoming energy arriving from the backward direction is substantially neutralized so as not to enter the receiver 3 in Fig. 1. It will also be understood that by forward I mean roughly in the same general direction as the direction in which radiant action is desired; by backward I mean roughly in the same general direction as the direction in which radiant action is to be suppressed.

The undesired backwardly arriving radiation sets up equal waves in the exciter and reflector antennae, both these sets of waves traveling from the apex toward the opening of the V. At the open end of the V the wave in the reflector antenna is reflected with a reversal of current and with no substantial reduction in amplitude. The corresponding wave in the exciter antenna is reflected with a reversal of current but also with an accompanying reduction of amplitude determined by the respective input impedance of each of the artificial lines 13 and 14. Assuming that the reflection takes place with a loss of three-quarters of the wave energy, i. e. with a reduction in the amplitude of fifty percent, the backwardly traveling waves in the exciter antenna will be only one-half the amplitude of the backwardly traveling waves in the reflector antenna when these two waves start back to the outer end of the V. The two backwardly traveling waves are now in the same phase (rather than in phase opposition as in the transmission case). Each of these waves will tend to destroy the other by inducing in the nearby conductor a wave of opposite phase. The waves in the reflector antenna being stronger will have a greater neutralizing or destroying effect upon the waves in the exciter antenna, and if the coupling and the length of the limbs are properly proportioned the waves in the lower or exciter antenna will just be completely neutralized by the time they reach the apex of the V.

The relationship of coupling of the antenna limbs to the effective input impedance of the terminating artificial lines 13 and 14 should be exactly the same as in the case of a transmission circuit. For the purpose of adjusting the devices 13 and 14 to their proper value with respect to the coefficient of coupling and length of the limbs, computations may be carried out upon the assumption that the system is to be used for transmission. These computations will be valid even if the system is actually to be used for reception. Similarly in the case of a transmission system, the computations may, if more convenient, be carried upon the assumption that the system is to be used for reception. Likewise if experimental measurements are to be made for adjusting the artificial lines in devices 13 and 14, these experimental measurements may be conducted on the basis of either transmission or reception, whichever is most convenient.

In the preferred form of my invention above described, the dimensions of the exciter and reflector antennae are identical and the spacing between the limbs of these antennae is uniform. The effective input impedances of devices 13 and 14 are purely resistive and considerably higher than the surge impedances of the limbs 11 and 12 to which they are connected. It is possible, however, to employ devices 13 and 14, which are not purely resistive but have a reactive component of substantial magnitude. In such a case either the lengths of the two antennae should be made correspondingly unequal so as to compensate for the phase shift introduced by such reactive components, or else phase shifting devices should be introduced at suitable points in one or both antennae.

In the preferred embodiment of my invention, moreover, the reflector antenna is purely parasitic, but the unidirectional radiant action of the antenna may be attained with a reflector antenna which is positively fed or excited. In such a case it is preferred to feed the reflector antenna at its outer end. It should also be understood that although the reflector antenna is mounted above the exciter antenna in the above described embodiment of my invention, my invention may be practised by means of a reflector antenna running below or inside or outside of the exciter antenna. The invention is also applicable to other types of antennae besides the V type such as, for example, single wire antennae.

Fig. 2 illustrates another form of my invention in which an exciter antenna 1 is fed through matching device 5 and over transmission line 4 from the transmitter 3. Adjacent and above the limbs 11 and 12 of this exciter antenna 1 are suspended the limbs 21 and 22 of the reflector antenna 2 whose apex is terminated in a resistor 25. The limbs 11 and 12 are suspended in an inclined manner so that the outer portions 13' and 14' of these limbs extend within a few feet of the ground. The level of the ground surface 10 is schematically indicated by dot-dash lines to make the inclination of the antenna limbs more clearly apparent. Preferably these limbs approach the ground in a curving manner as shown so that the end portions 13' and 14' are more nearly parallel to the ground than the portions nearer to the apex. Because of their proximity to the ground, the end portions 13' and 14' have high attenuation so that the wave which is reflected from the

end of these highly attenuated portions is much lower in amplitude than the forward wave. Furthermore, even after reflection this wave is further attenuated in the portions 13' and 14'. Because of their proximity to the ground the portions 13' and 14' have only a silght radiant action. Thus these highly attenuating, poorly radiating portions 13' and 14' perform somewhat the same functions as the concentrated artificial lines 13 and 14 used in the arrangement of Fig. 1. The reflector antenna 2 has its limbs extending generally along the same path as the limbs of the exciter antenna 1 but in the embodiment disclosed the limbs of the reflector antenna diverge slightly from the limbs of the exciter antenna toward the open end of the V as shown. Even without such divergence the attenuation in the limbs 21 and 22 of the reflector antenna 2 would be far less than the corresponding attenuation in the limbs 11 and 12 of the exciter antenna 1 near the out portion of the V because the separation of the limbs 21 and 22 from the limbs 11 and 12 is substantial in comparison with the separation of these limbs 11 and 12 from the ground near the outer end of the V. The divergence of the reflector antenna from the exciter antenna still further magnifies this difference in attenuation.

The operation of the system of Fig. 2 may be considered as generally similar to the operation of the system of Fig. 1. The two strongly attenuating, weakly radiating portions 13' and 14' act as reflecting means connected to the ends of limbs 11 and 12. These portions 13' and 14' may be considered as natural lines connected to the ends of limbs 11 and 12, and performing the functions of the concentrated artificial lines 13 and 14 of Fig. 1. It should be noted, however, that the input impedance of these open ended line portions 13' and 14' will not in general be purely resistive. To compensate the phase change introduced by the reactive components of 13' and 14' the limbs 21 and 22 of the reflector antenna are extended beyond the point at which the limbs 11 and 12 are considered as meeting the partially reflecting portions 13' and 14'.

It is more convenient, however, to analyse the action of the antenna system of Fig. 2 in a different manner. Since there are no definite points at which the limbs 11 and 12 merge into the attenuating portions 13' and 14', the mathematical analysis of the amplitude cannot be so simply set forth as in the system of Fig. 1. Instead of considering the forward waves in limbs 11 and 12 as being reflected with a fixed loss in the amplitude from a fixed junction point, it is more convenient to consider the forward waves in the exciter antenna as being reflected from the end points of the attenuating portions 13' and 14'. When the reflection of the end of the exciter antenna is analysed in this manner, it is clear that the backward reflected waves at the end of the exciter antenna should not generally be of the same amplitude as the backward reflected waves at the end of the reflector antenna since the greater attenuation of the backward reflected waves in the exciter antenna as they travel backward through portions 13' and 14' must be taken into account. The relationship of the backward waves should, however, be such that the radiant waves of the two waves will substantially neutralize each other. This general rule applies both to Fig. 1 and to Fig. 2.

Because of the proximity to ground of the limbs 11 and 12 of exciter antenna 1 in Fig. 2, the velocity of propagation of the waves in the outer portions 13' and 14' of these limbs is appreciably reduced. In order to secure the proper phase relationship between the backwardly traveling waves in the exciter antenna 1 and the reflector antenna 2 the limbs 21 and 22 of the latter antenna are preferably made somewhat longer than the corresponding limbs of the exciter antenna as shown in the drawing. If desired, however, phase shifters could be employed to secure the desired phase relationship.

The coefficient of coupling between the exciter antenna 1 and the reflector antenna 2 should be correlated to the amount of attenuation in the portions 13' and 14' of the exciter antenna, in the same way that the coefficient of coupling between the limbs of the exciter and reflector antennae in Fig. 1 should be correlated with the loss of amplitude of the waves upon reflection from the junctions of the artificial lines 13 and 14. In order to obtain the correct correlation between the coefficient of coupling of the two antennae and the attenuation of the exciter antenna in Fig. 2, it is preferred to erect the exciter antenna first and determine its coefficient of attenuation by test. Then the reflector antenna may be erected above it at such a computed distance as to provide a suitable coupling coefficient. The coupling coefficient can be computed comparatively accurately. If it is desired to make small adjustments so as to insure a still more exact correlation between the coupling coefficient of the two antennae and the attenuation of the exciter antenna, this may be done by slightly raising or lowering the outer end of the exciter antenna so as to vary the attenuation. The resistor 25 may also be slightly varied so that backwardly traveling waves in the reflected antenna will be partially reflected to form new forward waves. These new forward waves produced by reflection of the backward waves from resistor 25 will either add to or oppose the forward waves generated by reflection from the exciter antenna, and thus the adjustment of resistor 25 will have an effect similar to an alteration of the coupling between the two antennae. It is preferred not to employ a large reflection in resistor 25 since it is more desirable to produce most of the energy required in the reflector antenna by induction. One reason for this preference is that aperiodicity is enhanced by feeding the reflector by induction. Another reason is that wave energy introduced by induction is low near the apex and increases gradually so that the amplitude of the forward waves in the reflector antenna is greatest near the outer end where it is required for producing by reflection the necessary backward waves.

When the coefficient of coupling is properly correlated to the attenuation coefficient of the exciter antenna in the system of Fig. 2, the total backwardly directed effect of the reflector antenna will be such as to substantially neutralize the backwardly directed effect of the exciter antenna, so that the resultant radiant action will be substantially unidirectional.

The system shown in Fig. 2 may be modified by changing the length of one of the antennae and employing phase shifters to provide the desired phase relationship. Also the system of Fig. 2 may be arranged to work with a reflector antenna positively fed instead of energized merely by induction.

The arrangement of Fig. 2 as well as the ar-

rangement of Fig. 1 may be used either as a radiating antenna or as a receiving antenna.

The antenna system of Fig. 1 is substantially aperiodic over a wide range since the apparent input impedances of the concentrated lines 13 and 14 are substantially constant over a wide range of frequencies, and since the effective surge impedance of the antenna conductors 11 and 12 are substantially constant over a wide range of frequencies. The antenna system of Fig. 2 is also aperiodic to a certain extent although this arrangement will not exhibit aperiodic properties over such a wide range as in the system of Fig. 1.

Although I have described certain specific embodiments of my invention for the purposes of illustration, it will be understood that modifications, adaptations and variations thereof occurring to one skilled in the art may be made without departing from the scope of my invention as defined in the appended claims.

What I claim is:

1. A substantially aperiodic antenna system which comprises means including a first antenna for deriving a desired wave traveling along a first path to effect forward radiant action, means operatively associated with said antenna to derive by reflection an undesired wave traveling along said first path in a given direction, and means including a second, parasitic, antenna closely adjacent to said first antenna and extending substantially along the said path for deriving by its coupling with said first antenna a neutralizing wave traveling in said given direction along a second path substantially coincident with said first path and having such phase and amplitude as to neutralize the effect of said undesired wave and an impedance substantially equal to the surge impedance of said second antenna terminating said second antenna.

2. A substantially aperiodic transmitting antenna system which comprises means including a first antenna for deriving a desired wave traveling along a first path in a forward direction to effect forward radiation, means operatively associated with said antenna to derive by reflection an undesired wave traveling along said first path in a backward direction, and means including a second, parasitic, antenna closely adjacent to said first antenna and extending substantially along the said path for deriving by its coupling with said first antenna a neutralizing wave traveling in said backward direction along a second path substantially coincident with said first path and having such phase and amplitude as to neutralize the effect of said undesired wave and an impedance substantially equal to the surge impedance thereof terminating said second antenna.

3. A substantially aperiodic receiving antenna system which comprises means including a first antenna for deriving a desired wave traveling along a first path in a backward direction to effect forward reception, means operatively associated with said antenna to derive by reflection an undesired wave traveling along said first path in the backward direction, and means including a second, parasitic, antenna closely adjacent to said first antenna and extending substantially along the said path for deriving by its coupling with said first antenna a neutralizing wave traveling in said backward direction along a second path substantially coincident with said first path and having such phase and amplitude as to neutralize the effect of said undesired wave and an impedance substantially equal to the surge impedance thereof terminating said second antenna.

4. A substantially aperiodic receiving antenna system for receiving desired radiations from a desired direction and suppressing undesired radiations from undesired directions, which comprises an exciter antenna having a forward and a backward end, a transmission line coupled to said backward end so that backwardly traveling waves derived from the desired radiations pass directly along said antenna from said forward end toward said line, said antenna inherently producing forwardly traveling waves from said undesired radiation and having means to attenuatedly return backward along said antenna toward the line forwardly traveling waves resulting from the undesired radiations, and means including a reflector antenna spaced substantially between $\frac{1}{10}$ and $\frac{1}{100}$ of a wavelength from said exciter antenna for deriving from said undesired radiations and transferring to said exciter antenna neutralizing waves of such phase and amplitude as to neutralize said backwardly returned waves at the backward end of said exciter antenna and an impedance substantially equal to the surge impedance thereof terminating said second antenna.

5. A receiving antenna system according to claim 4, wherein said exciter antenna is terminated open-endedly at its forward end and wherein at least a portion of said exciter antenna is highly attenuating.

6. A receiving antenna system according to claim 4, which further comprises an artificial line connected to the forward end of said exciter antenna, the effective input impedance of said artificial line being different from the surge impedance of said exciter antenna.

7. A receiving antenna system according to claim 4, which further comprises a second similar exciter antenna and further similar means including a reflector antenna, said two exciter antennae being both coupled to said transmission line and being disposed to form a V, and said two reflector antennae being disposed to form a closely adjacent V.

8. A substantially aperiodic unidirectional antenna system comprising a transmission line, an exciter antenna having a backward end coupled to said line, and means for reflectingly terminating the forward end thereof, the characteristics of said antenna and termination being such as to derive in response to any given radiation arriving from a backward direction a first wave of a first given phase and amplitude traveling forward along said antenna and by reflection thereof to return along said antenna to said transmission line a second wave of a second given phase and amplitude, a parasitic reflector antenna extending over substantially the same path as said first antenna and having a terminating means to derive in response to said given radiation a third wave of said first given phase and amplitude traveling forward along said reflector antenna, means for coupling said reflector antenna to said transmission line for neutralizing the effect of said second wave in said line and means having an impedance substantially equal to the impedance of said second antenna for absorbing said third wave whereby the reception characteristic and also the radiation characteristic of said antenna system is unidirectional.

9. A receiving system comprising an antenna system in accordance with claim 8, and a wave receiver connected to said transmission line.

10. A transmitting system comprising an antenna system in accordance with claim 8, and a wave transmitter connected to said transmission line.

11. A substantially aperiodic antenna system which comprises an exciter antenna having a forward end and a backward end, a transmission line, means for coupling said line to said antenna at said backward end to cause said antenna to derive a given first wave traveling forward therein in response to a given energization of said line, partially reflecting means at said forward end of said antenna to partially reflect said given wave traveling forward in said antenna to produce a given weaker wave traveling backward therein, and a reflector antenna closely adjacent said exciter antenna and coupled thereto to derive therefrom a further wave traveling forward in said reflector antenna in response to said given first wave, terminating means for said reflector antenna to substantially fully reflect said further wave, the spacing between said reflector antenna conductor and said exciter antenna conductor being so selected with respect to the degree caused by reflection of said partially reflecting means that the said given weaker wave in said exciter antenna conductor is effectively equal and opposite to the fully reflected further wave in said reflector antenna conductor, and means having an impedance substantially equal to the surge impedance of said second antenna for absorbing said reflected wave whereby the radiation characteristic and also the reception characteristic of said antenna system is unidirectional.

12. An antenna system which comprises an exciter antenna having a forward end and a backward end, a transmission line, means for coupling said line to said antenna at said backward end, partially reflecting means at said forward end of said antenna to partially reflect any wave traveling forward in said antenna to produce a weakened backwardly traveling wave therein, and a reflector antenna closely adjacent said exciter antenna and having a forward end, terminating means for said forward end of said reflector antenna to reflect any wave traveling forward in said reflector antenna more completely than said partially reflecting means reflect any wave traveling forward in said exciter antenna and absorption means substantially equal to its surge impedance coupled to the backward end of said reflector antenna whereby the backward radiant action of the system is reduced.

13. An antenna system which comprises a V-type exciter antenna having two forwardly directed open ends and a backwardly directed apex, a transmission line, means for coupling said line to said antenna at its apex, partially reflecting means at said open ends of said antenna to partially reflect any wave traveling forward in said antenna to produce a weakened backwardly traveling wave therein, and a V-type reflector antenna closely adjacent said exciter antenna and having two forwardly directed open ends, terminating means for said open ends of said reflector antenna to reflect any wave traveling forward in said reflector antenna more completely than said partially reflecting means reflect any wave traveling forward in said exciter antenna whereby the backward radiant action of the system is reduced and absorption means substantially equal to the surge impedance of said reflector antenna coupled to the closed ends of said reflector antenna.

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