Dec. 7, 1948. G. H. BROWN 2,455,888

ANTENNA

Filed Aug. 12, 1944

Fig. 1.

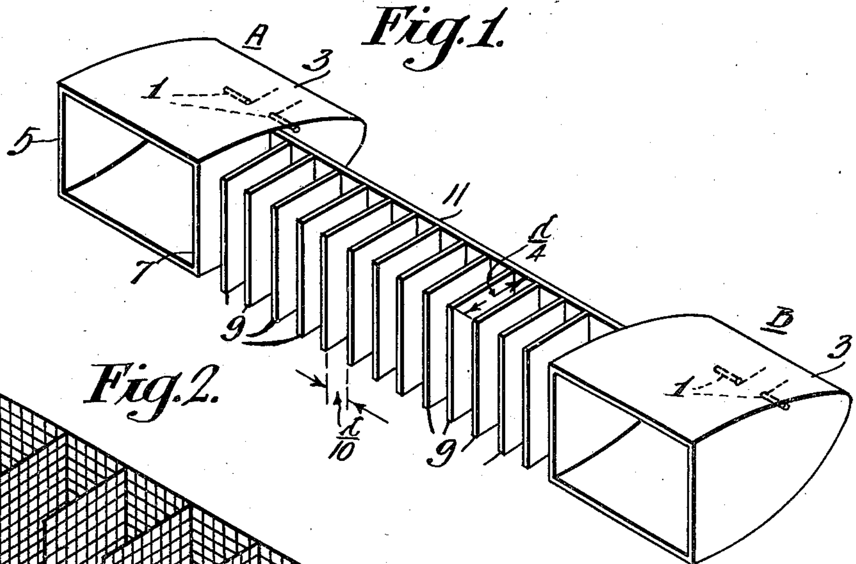


Fig. 2.

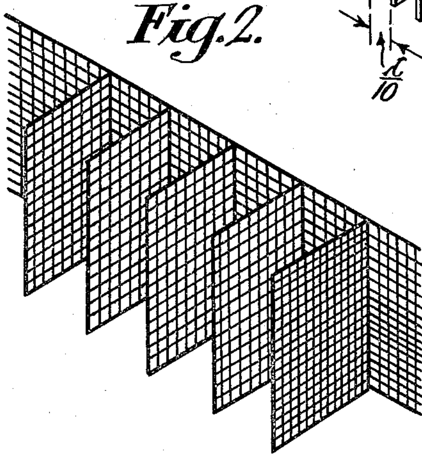


Fig. 3.

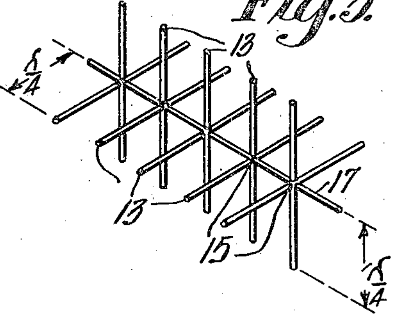
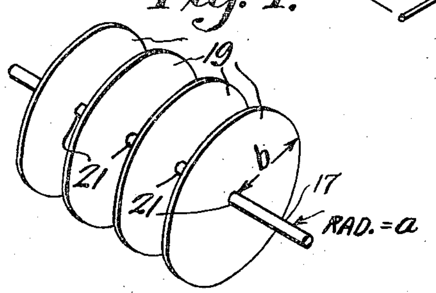


Fig. 4.



INVENTOR.
George H. Brown
BY C. D. Tuska
ATTORNEY

Patented Dec. 7, 1948 2,455,888

UNITED STATES PATENT OFFICE

2,455,888

ANTENNA

George H. Brown, Princeton, N. J., assignor to Radio Corporation of America, a corporation of Delaware

Application August 12, 1944, Serial No. 549,241

11 Claims. (Cl. 250—33)

1

This invention relates to radio antennas and has for its principal object the provision of means for preventing direct feed-through of radio frequency energy from one antenna to another nearby antenna.

In certain types of radio reflection object detecting systems, signals are radiated from one antenna and picked up by another antenna after reflection by an object. In such systems it is generally highly desirable to minimize or prevent the transmission of energy directly from one of the antennas to the other without reflection from the object. At the same time, the antennas must be placed relatively near to each other. Grounded shields interposed between the two antennas have been found to be ineffective, particularly at the higher frequencies, because currents induced in the shields by the transmitting antenna cause the shields to reradiate. Thus the shield tends to function merely as a coupling element between the two antennas. In accordance with the present invention, the two antennas are isolated from each other by shields constructed to form a plurality of short-circuited quarter-wave open-wire transmission lines. As is well known to those skilled in the art, a short-circuited transmission line presents substantially infinite impedance to the flow of current at the frequency at which the line is of one-quarter wavelength. The instant invention utilizes this phenomenon by placing a plurality of such lines in positions such as to prevent the flow of currents which tend to cause the transfer of energy from one antenna to the other.

The invention will be described with reference to the accompanying drawing of which Figure 1 illustrates one embodiment of the invention, showing its application to a pair of conventional reflector-type antennas; Figure 2 illustrates a modified shield construction in accordance with the invention; and Figures 3 and 4 illustrate further modified shield constructions.

Referring to Figure 1, a pair of antennas A and B are to be isolated from each other as described above. Each of the antennas is directive, and comprises a dipole 1 located at the focus of a cylindrical parabolic reflector 3. Each of the reflectors 3 is provided with side walls 5 and 7. In the absence of any further shielding means between the dipoles 1, energization of the antenna A will induce currents in its side walls. These currents will in turn induce currents in the side walls 5 of the antenna B, causing radiation therefrom to the dipole 1 of the antenna B.

To prevent the above-described coupling action from taking place, a plurality of flat plates 9 of conductive material are placed between the antennas A and B, with each connected at one of its edges to a conductive sheet 11 extending from the wall 7 of the antenna A, parallel to the line between the antennas, to the wall 5 of the antenna B. The plates 9 are parallel to the walls 5 and 7 and are spaced at intervals of approximately one-tenth wavelength at the frequency at which the system is to operate. Each of the plates 9 extends forwardly one-quarter wavelength from its point of connection to the sheets 11. The wall 7 of the antenna A, together with the nearest of the plates 9, acts as a quarter wavelength open-wire line, short-circuited at its rearward end by the sheet 11, thus presenting a substantially infinite impedance between the forward edges of the wall 7 and the first plate 9. Similarly, each pair of adjacent plates 9 presents a high impedance to the flow of current from one plate to the other. As a result of this action, current is effectively prevented from flowing in the wall 7 of the antenna A or any of the plates 9. Therefore, substantially zero coupling appears between the antennas A and B.

2

It is found in practice that the intermediate plates 9 between the first and last plate may be omitted, leaving only the first plate 9 adjacent the wall 7 of the antenna A and the last plate 9 adjacent the wall 5 of the antenna B, without seriously affecting the degree of isolation provided.

Although the invention has been described with reference to a specific type of antenna system, it is to be understood that its use is not limited to antennas of the type shown, nor to antennas employing parabolic reflectors. It will be clear to those skilled in the art without further discussion that other conductive bodies, such as screens or groups of parallel rods may be substituted for the quarter wave plates described above, as illustrated in Figure 2, without departure from the spirit of the invention, which contemplates broadly merely the provision of a plurality of parallel quarter wave conductors between the antennas to be isolated, with the corresponding ends of all of the conductors connected together to cause operation as short-circuited quarter wave lines.

Referring to Figure 3, an effect similar to that provided by the plates 9 of Figure 1 may be secured by means of a plurality of quarter-wave rods 13, connected at points 15 along a conductor 17. The points 15 are spaced at intervals substantially less than one-quarter wavelength, and cooperate in pairs as short-circuited open-wire quarter wave lines.

Referring to Figure 4, a further modification of the invention comprises a plurality of parallel conductive discs **19**, connected at their centers to points **21** on the conductor **17**. In order to provide high impedance resonance between the adjacent discs **19**, the radii of the discs are not necessarily one-quarter wavelength, because each pair of discs acts as a radial parallel conductor line, with tapered constants, that is the capacitance per unit length is largest at the outer end, gradually decreasing as the inner end is approached. Denoting the radius of the conductor **17** as a and the radius of each discs **19** as b, a and b must be so related that:

$$J_1\left(\frac{2\pi b}{\lambda}\right)K_0\left(\frac{2\pi a}{\lambda}\right)=J_0\left(\frac{2\pi a}{\lambda}\right)K_1\left(\frac{2\pi b}{\lambda}\right)$$

where λ is the wavelength,

$J_0(x)$ is the Bessel function of the first kind and zero order,

$J_1(x)$ is the Bessel function of the first kind and first order,

$K_0(x)$ is the Bessel function of the second kind and zero order,

$K_1(x)$ is the Bessel function of the second kind and first order.

I claim as my invention:

1. In a system including two antennas, apparatus for preventing direct-path transmission between said two antennas including a plurality of screens of conductive material each having substantially parallel front and back edges, and each substantially one-quarter wavelength wide from front to back, and means supporting said screens in spaced planes perpendicular to the line between said antennas, said supporting means comprising a conductor extending generally parallel to said line and connected to each of said screens at its back edge.

2. In a system including two antennas, apparatus for preventing direct-path transmission between said two antennas including a plurality of discs of conductive material disposed in spaced planes perpendicular to the line between said antennas, and a conductor extending generally parallel to said line and connected to each of said discs.

3. In a system including two antennas, apparatus for preventing direct-path transmission between said two antennas including a plurality of discs of conductive material disposed in spaced planes perpendicular to the line between said antennas, and a conductor extending generally parallel to said line and connected to each of said discs, the radius a of said conductor being related to the radius b of each of said discs by the equation:

$$J_1\left(\frac{2\pi b}{\lambda}\right)K_0\left(\frac{2\pi a}{\lambda}\right)=J_0\left(\frac{2\pi a}{\lambda}\right)K_1\left(\frac{2\pi b}{\lambda}\right)$$

where γ is the wavelength,

$J_0(x)$ is the Bessel function of the first kind and zero order,

$J_1(x)$ is the Bessel function of the first kind and first order,

$K_0(x)$ is the Bessel function of the second kind and zero order,

$K_1(x)$ is the Bessel function of the second kind and first order.

4. In a system including two antennas, apparatus for preventing direct-path transmission between said two antennas including a plurality of discs of conductive material disposed in spaced planes perpendicular to the line between said antennas, and a conductor extending generally parallel to said line and connected to each of said discs, the diameters of said conductor and said discs being such that the radial distance from the edge of each disc to the point of connection of said disc to said conductor lies between one quarter wavelength and one eighth wavelength at the lowest frequency at which said antennas are series resonant.

5. In a system including two antennas, apparatus for preventing direct-path transmission between said two antennas, including a plurality of parallel-conductor transmission line sections, means supporting said line sections between said antennas and perpendicular to the line between said antennas, said supporting means short-circuiting each of said line sections at least at one point thereon to provide high impedance paths between said antennas.

6. In a system including two antennas, apparatus for preventing direct-path transmission between said two antennas, including a plurality of plates of conductive material each having substantially parallel front and back edges, and each substantially one-quarter wavelength wide from front to back, and means supporting said plates in spaced planes perpendicular to the line between said antennas, said supporting means comprising a sheet of conductive material secured to said back edges only of said plates.

7. In a system including two antennas, apparatus for preventing direct-path transmission between said two antennas including a plurality of substantially flat bodies of conductive material each having a front edge and a back edge and each substantially one-quarter wavelength wide from front to back, and means supporting said bodies in spaced planes perpendicular to the line between said antennas, said supporting means comprising a conductor extending generally parallel to said line, connected to each of said bodies at its back edge.

8. In a system including two antennas, apparatus for preventing direct-path transmission between said two antennas, including a plurality of bodies of conductive material each having substantially parallel front and back edges and each substantially one-quarter wavelength wide from front to back, and means supporting said bodies in spaced planes perpendicular to the line between said antennas, said supporting means comprising a conductor extending generally parallel to said line, connected to each of said bodies at a point one-quarter wavelength distant at its back edge only.

9. In a system including two antennas, apparatus for preventing direct-path transmission between said two antennas, including a plurality of bodies of conductive material each having substantially parallel front and back edges and each substantially one-quarter wavelength wide from front to back, and means supporting said bodies in planes perpendicular to the line between said antennas, at intervals of approximately one-tenth wavelength at the frequency at which the system is to operate, said supporting means comprising a conductor extending substantially parallel to said line, connected to each of said bodies at its back edge.

10. An antenna system comprising two antennas spaced from each other, a sheet of conductive material disposed substantially in a plane parallel to the line between said antennas, and a plurality of plates of conductive material each

having substantially front and back edges and disposed in planes perpendicular to said line, at intervals of substantially less than one-quarter wave-length at the lowest frequency at which said antennas are series resonant, each having its back edges only connected to said sheet.

11. The invention as set forth in claim 10, wherein each of said plates is substantially one-quarter wavelength long from front to back at the lowest frequency at which said antennas are series resonant.

GEORGE H. BROWN.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,261,272	Newhouse	Nov. 4, 1941
2,272,312	Tunick	Feb. 10, 1942
2,281,196	Lindenblad	Apr. 28, 1942