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J. W. TILEY

2,413,085

ANTENNA SYSTEM

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Fig. 2.

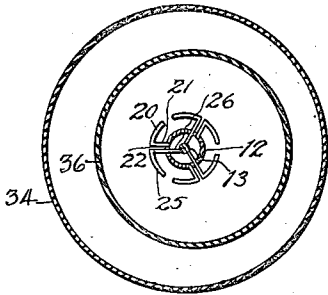


Fig. 10.

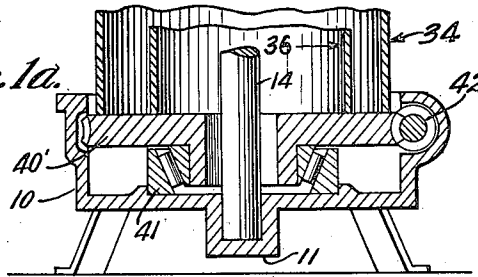


Fig. 1.

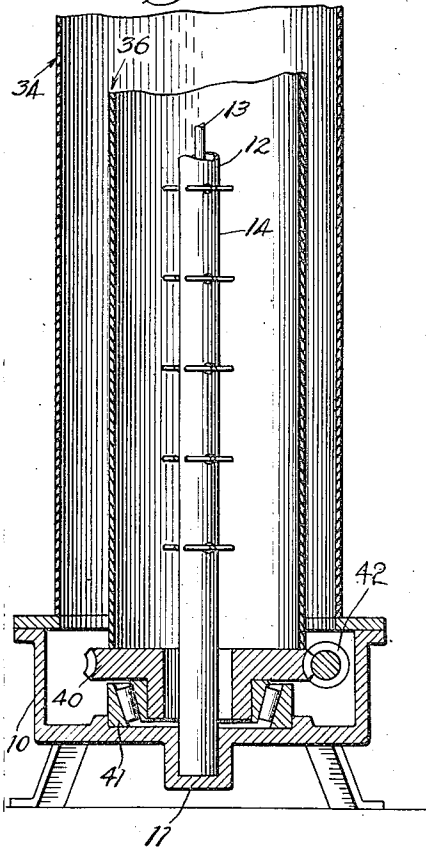
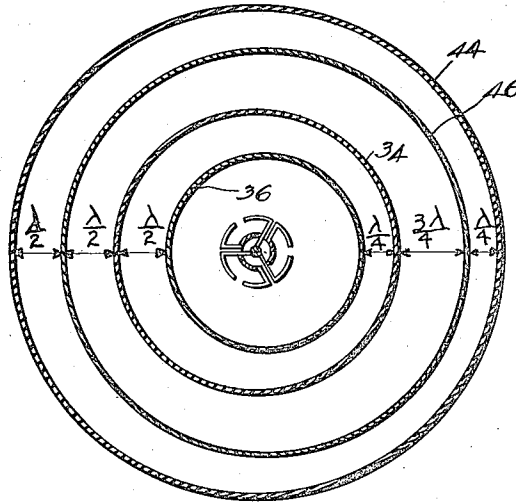
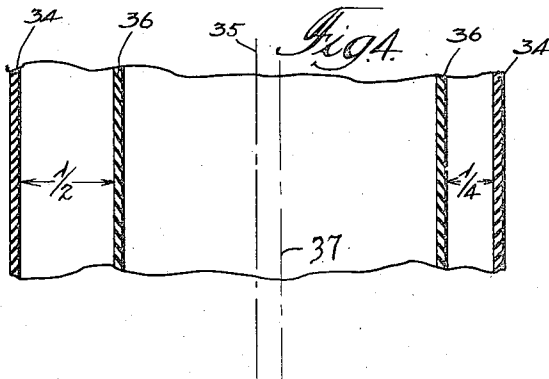


Fig. 3.



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UNITED STATES PATENT OFFICE

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ANTENNA SYSTEM

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8 Claims. (Cl. 250-11)

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This invention relates to an electrical apparatus and particularly to antenna systems. The invention pertains to an antenna system having directional controllable characteristics and provides a simple and effective construction for achieving this.

In high frequency communication systems operating at one thousand or more megacycles, it is desirable to provide beam characteristics for antennas. In many instances, it is necessary to change the direction of said beam characteristics and, in fact, it frequently occurs that rotation of said beam over a desired angular range is highly desirable.

The customary manner of obtaining a directional characteristic in an antenna system is to provide an antenna arrangement with a reflector, or reflectors so related to the antenna that interference patterns tend to eliminate radiation in undesired directions. Such antenna arrangements are relatively complex, require careful tuning and are difficult to move or rotate. At high frequencies, the problem of providing sliding connections and maintaining matching and phase adjustment is difficult. In the case of antenna systems using metal reflectors, unless a high ratio of reflector dimension to wavelength is maintained, it is found that a sharp beam is difficult to obtain.

By virtue of the invention hereinafter described, it is possible to obtain a controllable directional characteristic without recourse to complicated mechanism or critical electrical parts. The invention makes it possible to utilize a conventional antenna system having a more or less uniform radiation pattern without undue complexity. In general, the invention takes advantage of the phenomenon of reflection by dielectric materials to control the directional characteristic of an antenna system.

The invention in general provides for a variation in transmission path of radiation by changing the effective length of such paths through the interposition of members of dielectric material. By having a predetermined spacing between the dielectric members, it is possible to obtain a selective transmission of energy. In its more specific form, the invention provides for at least two dielectric members having a variable spacing therebetween in respect to a particular direction of transmission so that energy may be transmitted in said direction at one time and suppressed at another time. In its more practical form, the invention is restricted to ultra high frequencies where the wavelength involved is of the order of 10 cm. or less due to the necessity

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of dimensioning parts to within a substantial portion of a wavelength.

Referring now to the drawing,

Figure 1 shows an elevation view, partly in cross section, of a system embodying this invention.

Figure 1a is a detail showing the structure of Figure 1 modified.

Figure 2 is a sectional view on line 2-2 of Figure 1.

Figure 3 is a sectional view of a modified structure.

Figure 4 is a view of an enlarged portion of Figure 1.

Referring to Figures 1 and 2, platform or base 10 may be provided for supporting the entire mechanism. Base 10 may have centrally disposed apertured well 11 supporting any kind of antenna system 12. As shown here by way of example, antenna system 12 comprises a coaxial line having central conductor 13 and outer conductor 14. At various regions along the length of outer conductor 14, a bay of antenna units may be provided. Thus one bay of such units may consist of arcuate electrodes 20 supported on fingers 21 rigidly mounted at one point of outer conductor 14. Outer conductor 14 is apertured at 22 so that finger 21 may extend to the inside surface of outer conductor 14. Arcuate electrode 25 may be carried by finger 26 passing through aperture 22 and rigidly joined to central conductor 13. By proper choice of dimensions, electrodes 20 and 25 may form a dipole fed from within coaxial cable 12. In place of a coaxial cable, outer conductor 14 may be a wave guide with finger 26 terminating in a pick-up loop within the guide.

Such a type of dipole is generally provided in a series of two or more units uniformly disposed around cable 12. As shown here, three sets of dipoles are provided with equal angular spacing around the cable. Such an antenna array, if extending vertically, will provide a generally uniform horizontal pattern. By providing a series of superposed antenna bays, a desirable pattern may be obtained. It is understood of course that the proper vertical spacing between adjacent antenna bays is important so that radiation will be in phase. Inasmuch as such antenna systems are well known, a detailed description and discussion of such an antenna system is unnecessary.

In order to control the radiation pattern, outer dielectric member 34 is provided. As shown here, member 34 is a circular cylinder of substantially constant thickness. If different effects are de-

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sired then member 34 may have other shapes. Cylinder 34 may be supported on base 10 in any suitable fashion, and, in this particular instance, is preferably disposed concentric with the electrical center of the antenna system. Inasmuch as the antenna system here is symmetrical in horizontal planes (a vertical disposition of the antenna is assumed), the electrical center of the antenna system is substantially coincident with the geometrical center of coaxial cable 12. Thus horizontal radiation patterns of the antenna system, if disposed in free air, would be circular with respect to the axis of the coaxial cable.

Referring to Figure 4, the axis of cylinder 34 is indicated at 35. Eccentric with respect to axis 35 is inner dielectric member 36 which, for convenience, may also be a circular cylinder having axis 37. Both cylinders are preferably constructed of dielectric material having low transmission losses for radiant energy such as polystyrene or quartz. The thickness of cylinders 34 and 36 should preferably be uniform, and small with respect to the wavelength employed, that is, considerably less than a quarter wavelength.

Cylinder 36 is rotatably mounted upon turntable 40 carried by thrust bearing 41. Turntable 40 may have its peripheral portion formed as a gear and may be driven by worm 42. As shown in Figure 1, cylinder 34 is carried upon base 10. It is also possible to rotate both cylinders 34 and 36 by mounting them upon turntable 40' as shown in Figure 1a. Thus in both figures, as the turn-table rotates, the direction of maximum and minimum cylinder separation will also rotate.

It will be apparent that the portions of wall 36 on the opposite sides of axis 35 are displaced differently therefrom. For maximum directional effect, the spacing between walls 36 and 34 in one direction should be a quarter wavelength, and on the opposite side of axis 35, the spacing between walls 34 and 36 should be a half wavelength. Under these conditions, waves will propagate freely in the direction where the spacing is a quarter wavelength and will be substantially entirely reflected in the direction when the spacing is a half wavelength. The impedance of the antenna input terminals and the degree of directivity of the antenna system may be adjusted by varying the spacings shown in Figure 4 and the thickness of the dielectric cylinders, but as these factors may be calculated by methods well known to those skilled in the art it is unnecessary to describe them here in detail. However, an improved application of my invention which would not be evident from calculation is shown in Figure 3.

Figure 3 illustrates the case where an antenna system similar to that shown in Figures 1 and 2 is surrounded with two additional dielectric cylinders 44 and 46. Cylinder 44 is concentric with cylinder 34 and axis 35 while cylinder 46 is concentric with cylinder 36. In the direction shown as "left" in the figure the spacing between the cylinders is a half wavelength in each case. In the right hand direction the spacing is:

Cylinder 36 to cylinder 34, one-quarter wavelength
Cylinder 34 to cylinder 46, three-quarter wavelength
Cylinder 46 to cylinder 44, one-quarter wavelength.

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The addition of cylinders 44 and 46 will enhance the directive properties of the antenna system of Figures 1 and 2 without affecting the impedance at the antenna terminals to any marked extent.

If it is desired to rotate the direction of wave emission, a structure similar to that of Figure 1 may be used, the platform 40 being made large enough to accommodate the bases of all the cylinders except the outermost one. Cylinder 34, being mounted concentrically may be rotated without effect on its operation, and eccentrically disposed cylinders 36 and 46 are suitably located on the rotating platform 40.

It is understood that the drawing does not show the parts in proper proportion. Thus, the diameter of the outermost portions of the antenna system proper in practice would be smaller in proportion to the cylinder diameters than is actually shown. The smaller the diameter of the antenna proper compared to the dielectric cylinders and the smaller the thickness of the dielectric cylinders compared to a quarter wavelength the more accurately the system will perform.

What is claimed is:

1. A directional antenna system comprising an antenna having a radiation pattern in a predetermined plane, a dielectric member disposed in the path of said radiation from said antenna system, said dielectric member having a thickness along the path of radiation of less than a quarter wavelength, a second dielectric member interposed between said antenna and said first dielectric member, said second member having a thickness of less than a quarter wavelength, and means for varying the distance between said dielectric members, said variation being sufficiently great so that said two dielectric members cooperate to transmit radiation from the antenna in one position and to substantially suppress radiation in another position.

2. A directional antenna system according to claim 1 wherein the spacing between said dielectric members in one direction is an odd number of quarter wavelengths, and in another direction is an even number of quarter wavelengths.

3. A directional antenna system according to claim 1 wherein the spacing between said dielectric members in one direction is an odd number of quarter wavelengths and wherein said spacing in the opposite direction is an even number of quarter wavelengths.

4. A directional antenna system according to claim 1 wherein said dielectric members are cylinders and dimensioned so that the spacing between said cylinders in one direction is an odd number of quarter wavelengths and in the opposite direction is an even number of quarter wavelengths.

5. A directional antenna system comprising an antenna having a radiation pattern in a predetermined plane, a plurality of pairs of dielectric members disposed in the path of said radiation from said antenna system, each dielectric member having a thickness along the path of radiation of less than a quarter wavelength, means for varying the distance between the dielectric members forming each pair, said variation being sufficiently great so that the dielectric members forming each pair cooperate to transmit radiation from the antenna in one direction and to substantially suppress radiation in another direction.

6. The system of claim 5 wherein said dielec-

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tric members are cylinders with the separation between cylinders being an odd number of quarter wavelengths in said one direction and being an even number of quarter wavelengths in said other direction.

7. A directional antenna system according to claim 1 wherein said dielectric members are cylinders with the spacing between said cylinders in one direction being an odd number of quarter wavelengths and the spacing in the opposite direction being an even number of quarter wavelengths and wherein one of said cylinders is

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mounted on a turntable, said turntable being adapted to turn said cylinder and vary said direction.

8. The system of claim 5 wherein all but the outermost of said cylinders are mounted on a turntable, with one of each pair of cylinders being mounted concentric to said turntable and with the remaining cylinders being mounted eccentric to said turntable but having a common center.

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