Dec. 1, 1970 M. GILLER 3,545,001

ANTENNA FEED COMPRISING DIPOLE ARRAY WITH CONDUCTIVE GROUND PLANE

Filed April 24, 1968 2 Sheets-Sheet 1

FIG. 1

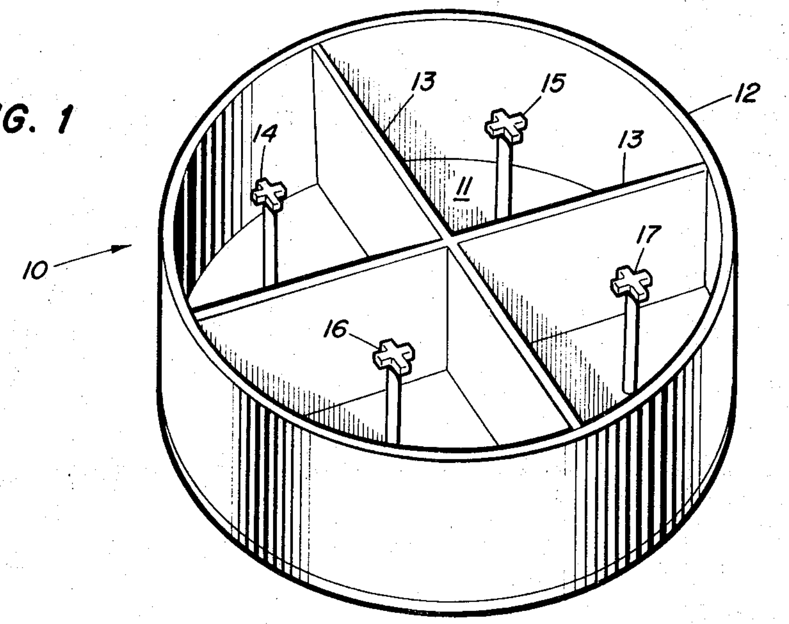

FIG. 2

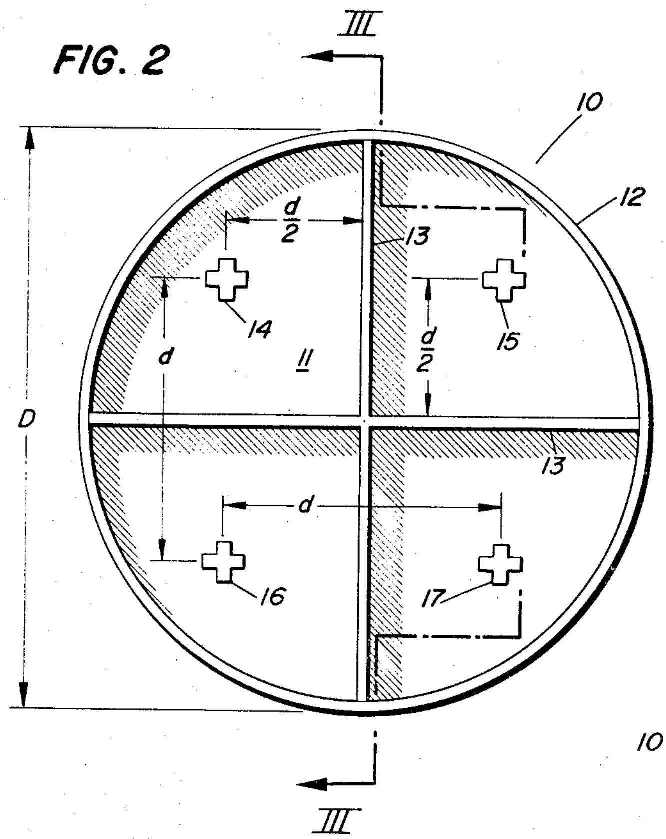

FIG. 3

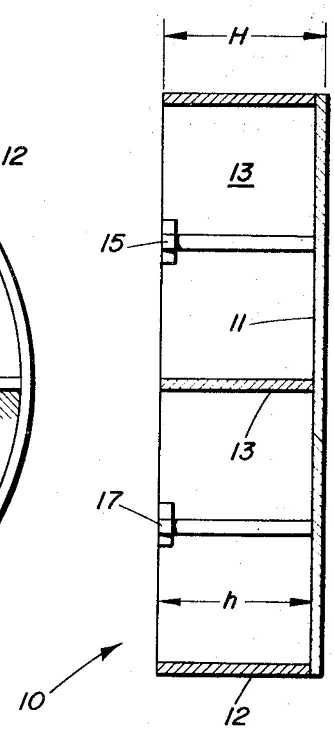

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FIG. 4

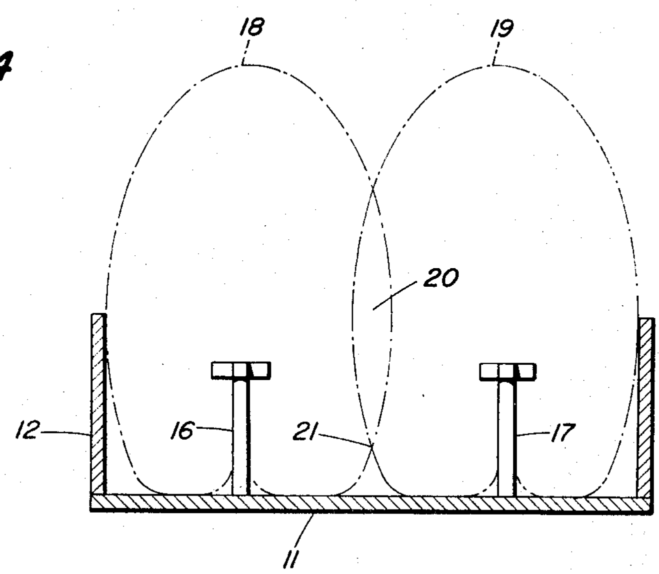
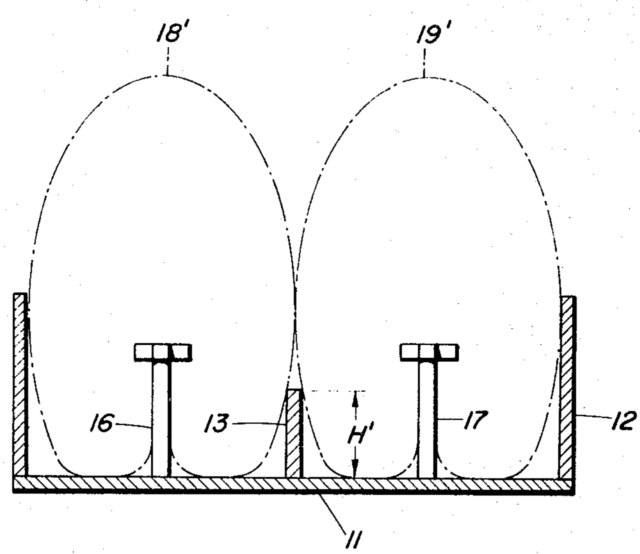


FIG. 5



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ANTENNA FEED COMPRISING DIPOLE ARRAY WITH CONDUCTIVE GROUND PLANE

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ABSTRACT OF THE DISCLOSURE

This invention describes a feed for an antenna such as a parabolic antenna for receiving and transmitting electromagnetic energy. The inventive feed incorporates four dipole radiation devices which are located symmetrically on a ground plane. By locating the feed at the focus of the parabolic reflector the energy is transmitted in substantially parallel lines. However, the directivity of the antenna is dependent upon the directivity of the feed. The diameter of the ground plane is a contributing feature to the directivity of the antenna system and therefore an increase of directivity of the feed requires an increase in the physical size of the ground plane. This invention shows that the ground plane is electrically extended by placing a conductive fence, or side wall, around the entire periphery of the ground plane. In this manner the electrical size of the feed is increased but the physical diameter is held to a minimum. This is advantageous because it permits a physically smaller feed and consequently the antenna gain is increased but the sidelobes are decreased. The cross coupling between the four dipoles is minimized by placing a conductive barrier between the dipoles. The barrier extends across the ground plane and is in electrical contact with both the ground plane and the side wall.

It is well known that the directivity of a feed for a parabolic antenna is directly dependent upon the area of the aperture which feeds the antenna; the larger the aperture the greater the directivity. Because an increase of directivity requires an increase of the aperture it is difficult to increase the directivity in instances where the size of the parabolic reflector is limited because of space and weight considerations. In such instances a feed aperture which is less than desirable must be used. An increase in the size aperture is also undesirable because the blockage of the antenna by the aperture is also increased. Although an increased aperture has several disadvantages, it also has several advantagse. The increased directivity of the antenna feed decreases the illumination on the edges of the antenna. This results in a decrease of the sidelobes of the antenna pattern. Another desirable characteristic is an increase in the antenna gain. Because of these advantages, an antenna feed which has a large electrical aperture but a small physical size is desirable. Such an antenna feed would possess all the desirable characteristics and eliminate all the disadvantages.

It is sometimes desirable to utilize more than a single radiating element in a particular antenna feed. The disadvantage of this type of antenna feed arises primarily due to the cross coupling of the two radiating members. This cross coupling results in the degradation of the radiation pattern of both the radiating means and also has an undesirable effect on the directivity of the antenna.

These disadvantages are overcome by the inventive antenna feed which electrically extends the aperture of the feed while simultaneously maintaining a small physical configuration. This is accomplished by the addition of a conductive side wall, or flange, to the aperture ground plane. This side wall results in a large electrical aperture while keeping the physical diameter of the aperture at a

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minmium. The cross coupling between the dipoles of the array is minimized by the addition of a conductive barrier which extends across the ground plane between the dipoles. The barrier is electrically connected between the ground plane and the side wall.

It is therefore an object of this invention to provide an antenna feed which is electrically large but physically small.

It is another object to provide an antenna feed in which the electrical dimension is extended by the use of a conductive side wall.

It is another object of this invention to provide such a device in which the side wall is substantially perpendicular to the ground plane.

It is another object to provide such a device which utilizes more than one radiating member.

It is another object to provide such a device in which the cross coupling of the radiating members is maintained at a minimum.

It is another object to provide such a device in which the cross coupling is minimized by a conductive flange extending between the radiating members.

These and further objects and features of the invention will become apparent upon reading the following description in conjunction with the accompanying drawings, wherein like numbers indicate like or equivalent elements and in which:

FIG. 1 is an isometric view of the inventive antenna feed;

FIG. 2 is a view looking straight down into the antenna feed;

FIG. 3 is a view taken along the line III—III of FIG. 2;

FIG. 4 is a representation of the radiation patterns without the use of a barrier between the radiating elements; and

FIG. 5 shows the radiation patterns when a barrier is used between the radiating elements.

FIG. 1 shows the inventive feed represented generally by reference numeral **10**. The antenna feed is comprised of a circular ground plane **11** having a conductive flange, or side wall, **12** extending around the entire circumference thereof. The side **12** is physically and electrically connected to ground plane **11**. An array of radiating elements **14** through **17** is supported by the ground plane **11**. An energy source (not shown) feeds the radiating members **14** through **17**. The radiation is fed by the radiating means **14** through **17** against the ground plane **11** and side **12**. The exact nature of the radiating elements forms no part of the invention as any of the many such elements available can be used. The cross coupling which would ordinarily occur between the radiating elements is minimized by the insection of a conductive barrier **13**. In the embodiment shown the barrier **13** has the form of a cross. The arms of the cross extend across the entire ground plane **11** and the four ends are in electrical contact with the side **12**.

As best seen in FIG. 2 the four radiating elements are spaced a distance d apart and are spaced a distance $d/2$ away from the barrier **13**. For optimum operation the distance d will equal one-half λ; where λ is the wavelength at the desired operating frequency. The radiating elements are therefore symmetrically arranged on ground plane **11**.

As best seen in FIG. 2 the height of side **12** is indicated as H and the diameter of the ground plane is indicated as D. The effective radiation area of the ground plane is equal to $D+H$. For an idealized antenna feed the aperture is a direct function of wavelength and, therefore, as the wavelength increases the diameter of the aperture must also increase. It is therefore evident in the inventive system that the effective aperture of the array can be increased by increasing the height H of the side wall without changing the diameter D of the antenna feed. The aperture can therefore be increased without suffering the disadvantage of increasing the physical diameter of the antenna feed. The directivity of an antenna having a fixed diameter can therefore be increased beyond limits possible with available antenna feeds.

The advantage of the barrier **13** is best understood by viewing FIGS. 4 and 5. FIG. 4 shows the radiation pattern of two dipoles **16** and **17** without the use of a barrier. The radiation patterns **18** and **19** are seen to overlap to form an area **20** of interfering patterns. This overlap area degrades the patterns of both dipoles **16** and **17** and also undesirably effects the directivity of the overall pattern of the antenna feed. The overlapping area **20** of the radiation patterns is effectively minimized by the insertion of conductive barrier **13**, as shown in FIG. 5. The presence of barrier **13** causes the radiation patterns **18′** and **19′** to become more elliptical and thereby reduces the interfering area **20**. The increased elliptical shape of the patterns **18′** and **19′** also results in an increase of the directivity of the antenna feed. Obviously this results in an increase of the antenna directivity.

FIGS. 4 and 5 are also useful in showing how side **12** aids in increasing the directivity of the feed **10**. The radiation patterns **18** and **19** are prevented from spreading outwardly into a substantially circular configuration by the side **12**. The directivity is thereby improved in this manner as well as the effective increased area of the aperture. The side **12** is therefore seen to increase the feed directivity in two manners.

It should be noted that the height H′ of the barrier can be less than the height H of the side **12**. The primary requirement on the height H′ of flange **13** is that it extends at least as high as the lowest crossing point of the radiation patterns. In FIG. 4 this crossing point is indicated by reference numeral **21**. The barrier **13** can extend above this point and be as high as the side wall **12**. The height *h* of the radiation elements **14** through **17** can be greater than, equal to, or less than the height H of the side wall. As the height *h* of the radiating elements is changed the crossing point **21** of the radiation patterns will vary and, therefore, the required minimal height H′ of the barrier **13** will also vary; this is a design consideration within the purview of one skilled in the art. The use of side **12** and barrier **13** results in an antenna feed which possesses all the desired characteristics of a physically large feed but eliminates all the disadvantages of such a feed. An antenna feed constructed with a side **12** and barrier **13** can be expected to have sidelobes which are 4 to 6 db lower than a feed of equal diameter D and not having these two features. The gain can be expected to be as high as 2 db over that of the prior art feed. A bandwidth of at least 25% can be expected.

Because the antenna feed must be mechanically strong the interior cavities can be filled with a dielectric potting compound. If this is done it is advisable to extend the

barrier height H′ to equal the side height H. The radiating elements **14** to **17** will be physically supported by the potting compound, in which case their height *h* will also equal height H of side **12**.

The feed can be equipped with a dielectric radome, or cover, which is placed over the open end of the feed. Construction can be simplified by printing dipoles **14** to **17** on the radome. The use of potting compound is then optional.

In the embodiment shown and discussed ground plane **11** is a planar surface. The directivity of the feed **10**, and consequently the advantages resulting therefrom, can be increased by curving ground plane **11** into a concave surface. Such a curve would preferably be parabolic, but for fabrication convenience could be spherical.

Although this invention has been described with respect to a particular embodiment, it is not to be so limited as changes and modifications may be made therein which are within the spirit and scope of the invention as defined by the appended claims.

The invention claimed is:

1. A feed device for an antenna comprising:

a planar conductive base having a circular configuration;

a conductive side extending around the circumference of said base; said conductive side being electrically connected to said conductive base and normal thereto;

conductive dividing means extending across said base; said dividing means being normal to said base and in electrical contact with said base and said conductive side; said dividing means dividing said base into four equal quadrature segments;

four radiation means; each of said radiation means being located within one of said segments.

2. The device of claim **1** wherein said radiating means are dipoles located in each of said quadratures.

3. The device of claim **2** wherein said side extends above said dividing means and said dipoles.

4. The device of claim **2** wherein said side and said dividing means extend equally above said base; and said dipoles lie below said side and said dividing means.

5. The device of claim **2** wherein said dividing means, said side and said dipoles extend equal distances above said base.

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343—817, 848