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(54) Lens/polarizer/radome.

(57) To modify the antenna pattern of an existing array antenna (12), a unitary assembly made up of a dielectric lens (13) of appropriate shape, a horizontal polarization filter (17), a circular polarizer (19) and absorbing material (21,23,24) are disposed to cover the aperture of the existing array antenna (12). A quarter-wave matching element (15) is provided on the transmission faces of the lens (13). The circular polarizer (19) is made of five layers of dielectric material, each layer being provided with a directional pattern of metallic meander lines (19a, 19b, 19c, 19d, 19e).

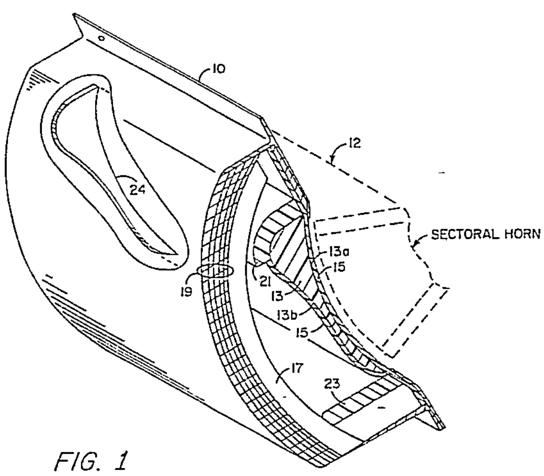

FIG. 1

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Description

LENS/POLARIZER/RADOME

Background of the Invention

This invention pertains generally to directive antennas for radio frequency energy, and particularly to a Lens/Polarizer/Radome used in conjunction with other types of antennas.

It is sometimes necessary to modify the shape of the antenna pattern of an array of antennas. In such case it would be standard practice to redesign the array to attain the desired modified antenna pattern. However, such an approach could be relatively difficult and expensive to implement, especially if implementation were to require retrofitting an appreciable number of systems in the field.

Summary of the Invention

With the foregoing background in mind, it is a primary object of this invention to provide a Lens/Polarizer/Radome that may be easily attached to an existing array antenna to modify the antenna pattern in a desired way without significantly affecting the other operating characteristics of such array antenna.

The foregoing and other objects of this invention are attained generally by providing a Lens/Polarizer/Radome incorporating an appropriately shaped dielectric lens along with impedance matching and filtering structures, such Lens/Polarizer/Radome being adapted for mounting on the existing array antenna to form a unitary structure.

Brief Description of the Drawings

For a more complete understanding of this invention, reference is now made to the following description of the accompanying drawings wherein:

FIG. 1 is an isometric drawing, partially cross-sectional, showing a Lens/Polarizer/Radome according to a preferred embodiment of this invention in place over an array antenna; and

FIGS. 2 and 2A show a polarizer here contemplated.

Description of the Preferred Embodiment

Referring now to FIG. 1, it may be seen that the elements of the contemplated Lens/Polarizer/Radome are mounted within a flanged frame 10 that is dimensioned to permit mounting in any convenient manner on the face of an array antenna 12, here a linear array of sectoral horns (not numbered). The elements of the contemplated Lens/Polarizer/Radome are a dielectric lens 13, a quarter-wave matching element 15, a polarization filter 17 and a polarizer 19. In addition, absorbers 21, 23, 24 are provided as shown.

The dielectric lens 13, here fabricated from polyethylene having a dielectric constant of approximately 2.3, is shaped to have a first surface 13a complementary in shape to the ends of the sectoral horns (not numbered). To put it another way, first surface 13a is shaped to present nearly an equiphase surface to fields produced by the sectoral horns (not numbered). A second surface 13b of the dielectric lens 13 is shaped to adjust the phase delay of rays passing through the dielectric lens 13 as required to attain a desired distribution across the aperture (not numbered) of the Lens/Polarizer/Radome. As is known, the phase delay at any point through the dielectric lens 13 is directly related to the thickness of the dielectric lens and to the square root of the dielectric constant and inversely related to the wavelength of the electromagnetic energy being transmitted or received. In the illustrated example, where it is desired to increase the elevation angle of the upper 3 dB point of the antenna pattern, i.e., increase the coverage in elevation, the cross-section of the dielectric lens 13 is shaped as shown. It is noted here that the first surface 13a of the dielectric lens 13 need not be concentric with the end of the sectoral horns (not numbered). As a matter of fact, in order to optimize elevation sidelobes it is here preferred that the dielectric lens 13 be rotated so that the upper end of the first surface 13a is slightly closer to the sectoral horn than the lower end of the first surface 13b.

The quarter-wave matching element 15 here is a sheet of foam rubber having a thickness of one-quarter wavelength of electromagnetic energy passing through the dielectric lens 13 in either direction. The dielectric constant of the foam rubber is equal approximately to the square root of the dielectric constant of the polyethylene of the dielectric lens 13. The quarter-wave matching element 15 is affixed with an electrically thin layer of R.F. transparent adhesive to the first and second surfaces 13a, 13b of the dielectric lens 13.

The polarization filter 17 and polarizer 19 here are used to convert circularly polarized energy to linearly polarized energy and vice versa and to compensate for changes in the cross-polarization component of the electromagnetic energy out of each sectoral horn (not numbered). As is known, such a cross-polarized component increases with non-principal plane angles. The polarization filter 17 is conventional, here being made up of parallel metal plates spaced at about 0.4 wavelengths at the upper end of the frequency band of interest and about 3/4 inches deep. The polarization filter 17, as shown, conforms with the polarizer 19. On transmission, then, only horizontally polarized energy is passed through the polarization filter 17 to the polarizer 19.

Referring now to FIGS. 2 and 2A, it will be seen that the polarizer 19 here consists of four sheets of dielectric material essentially transparent to the radio frequency energy passing through the Lens/Polarizer/Radome. Before assembly a metallic meanderline 19a, 19b, 19c, 19d, 19e is formed on each one of the sheets in accordance with the table shown in FIG. 2A. The meanderlines are oriented so that each is inclined at an angle of 45° to the horizontal. As a result, then, linearly polarized energy passing through the polarizer 19 is converted to circularly polarized energy. Because the polarizer 19 is a reciprocal device, circularly polarized energy passing through the polarizer 19 is converted to linearly polarized energy.

To complete the contemplated Lens/Polarizer/Radome, absorbers 21, 23, 24 fabricated from any known absorbing material are affixed (as by cementing with an electrically thin layer of R.F. transparent adhesive) to the perimeter of the dielectric lens 13 and adjacent areas. The absorbers 21, 23, 24 then are effective to prevent unwanted nulls in the antenna pattern and radiation from the ends of the dielectric lens 13. In addition, spaces between the elements of the just-described Lens/Polarizer/Radome preferably are filled with dielectric material (not shown) having a dielectric constant approximating 1.0. Such a filler then has no appreciable electrical effect, but rather serves only to make the Lens/Polarizer/Radome a unitary structure.

Having described apparatus that may be used to implement the contemplated invention, it will now be apparent to one of skill in the art that modifications may be made without departing from the inventive concept. It is felt, therefore, that this invention should not be restricted to its disclosed embodiment, but rather should be limited only by the spirit and scope of the appended claims.

Claims

1. In an antenna system wherein the antenna pattern of energy originating at the aperture of an array antenna is to be modified, the improvement comprising:

(a) a dielectric lens disposed to cover at least a portion of the aperture, the dielectric lens being fabricated from a material having a dielectric constant exceeding 2.0 and being shaped to modify the antenna pattern as desired; and

(b) impedance matching means disposed between the array antenna and the dielectric lens.

2. The improvement as in claim 1 comprising, additionally, absorbing means disposed around the periphery of the dielectric lens to control sidelobes and pattern nulls.

3. The improvement as in claim 2 comprising, additionally:

(a) a polarization filter disposed over the dielectric lens to limit the plane of polarization of energy passing to and from the dielectric lens to a predetermined plane; and

(b) a polarizer disposed over the polarization filter to convert the polarization of energy originating at the aperture to circular polarization.

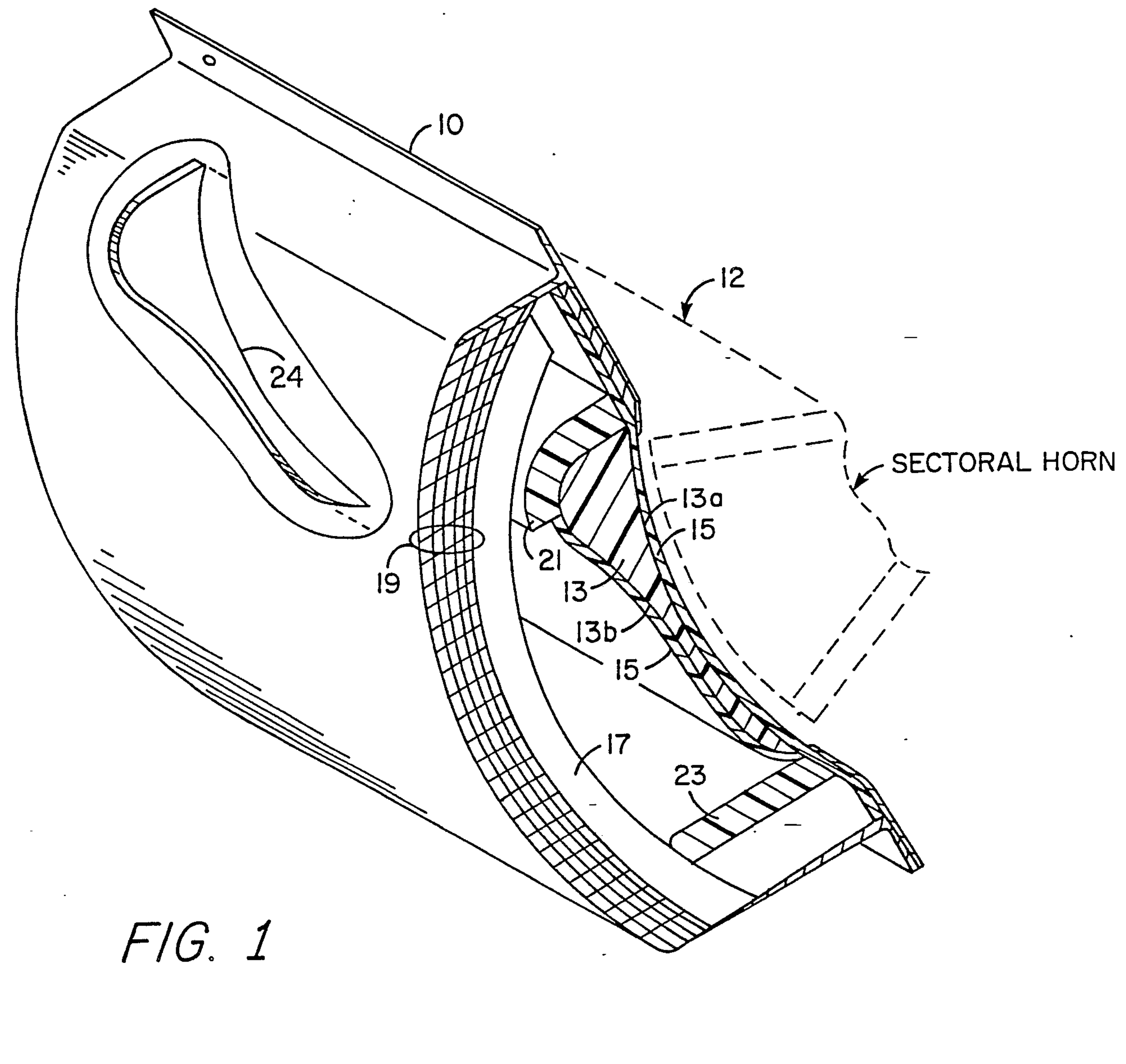

FIG. 1

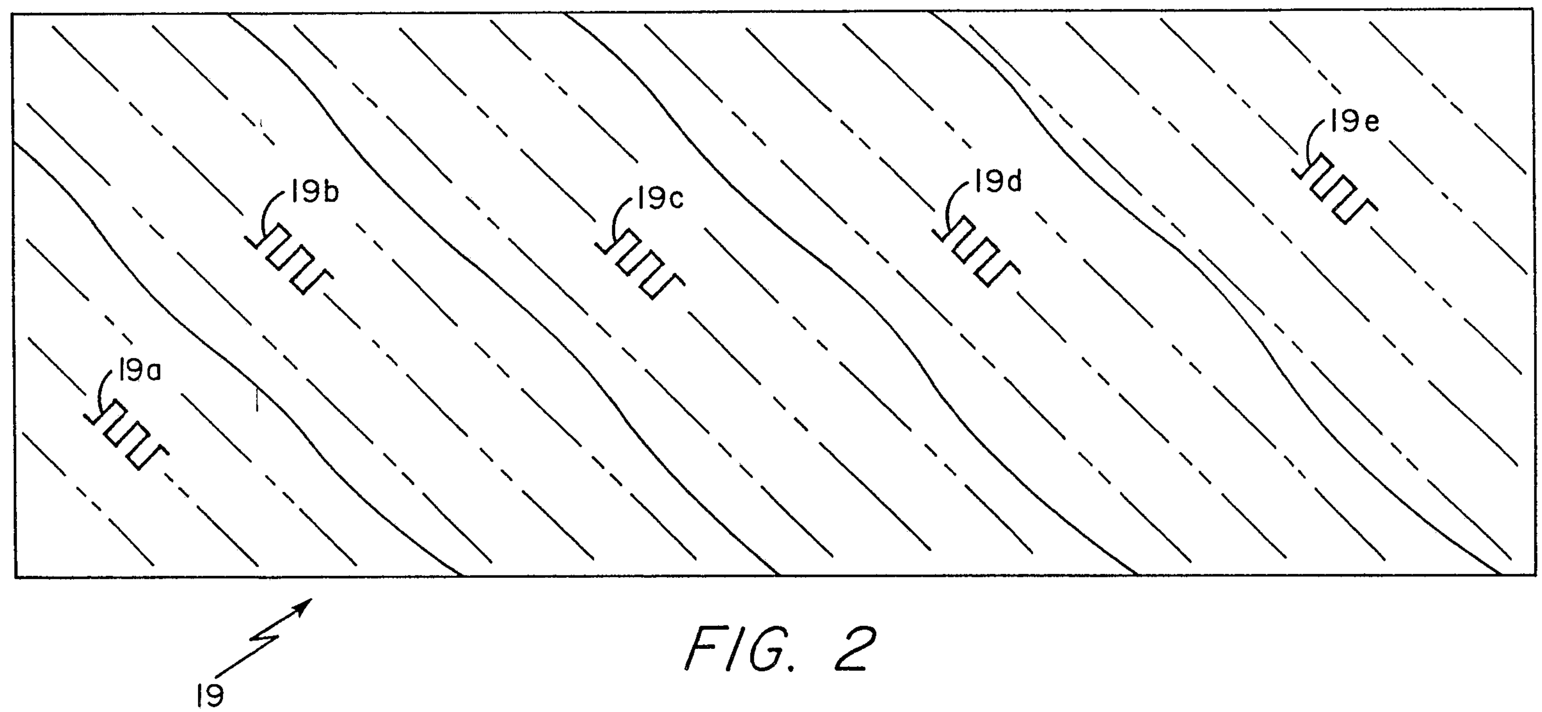

FIG. 2

TABLE I						
ETCHED DIMENSIONS						
TOL	A	B	C	D	E	F
P/N	±.001	±.001	±.002	±.003	±.002	±.002
19a,19e	.004	.005	.082	.320	.028	.018
19b,19d	.006	.006	.125	.320	.045	.0285
19c	.009	.009	.137	.320	.050	.034

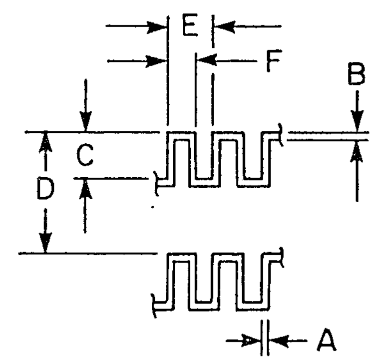

FIG. 2A