THIN SANDWICH TELEMETRY ANTENNA

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ABSTRACT
A thin sandwich slot antenna is provided which produces a cardiod shaped antenna pattern. The antenna structure requires no antenna cavity or other remote structure behind the antenna. A thin-film antenna is supported by a thin dielectric strip and contoured to the shape of support structure. A metallic support structure becomes the ground plane for the antenna otherwise a metallic ground plane is placed behind the radiating element.

7 Claims, 3 Drawing Figures
THIN SANDWICH TELEMETRY ANTENNA

BACKGROUND OF THE INVENTION

A need exists for a missile or aircraft antenna of such size as to fit relatively small diameter missiles or be readily contoured to moderately contoured surfaces. Such an antenna should be capable of functioning with associated antenna components having a minimum or negligible internal missile volume. Conventional telemetry slot antennas do require support structure in the form of a cavity behind the slot which must be internal to missile structure. The instant invention provides a satisfactory omnidirectional pattern while meeting the space related requirements necessary for operation.

SUMMARY OF THE INVENTION

A thin sandwich antenna comprises a thin film or foil forming the radiating element of the antenna and a dielectric support for insulating the antenna foil from adjacent substructure and ground plane and attaching the foil to support structure. The antenna and dielectric conform to contoured support surfaces and need no special accommodations. The antenna pattern is cardiod shaped. For selected frequency bands of operation, the antenna dimensions are initially empirically determined, providing maximum operating efficiency.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 discloses a preferred embodiment of the thin film antenna mounted on a support structure with extraneous structure omitted.

FIG. 2 is a sectional view along the lines 2—2 of FIG. 1, with a coaxial feed arrangement also shown.

FIG. 3 is a response curve for the antenna mounted on the external skin of a missile.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings wherein like numbers represent like parts in the several views, FIG. 1 discloses an antenna 10 mounted on a contoured support structure 12, such as the outer curved surface of a small diameter missile. A fin 28 is shown, thus indicating one direction of the antenna. An outer edge of the antenna is coupled to the missile skin (ground plane) by a ground strap 14. Antenna 10 is generally rectangular in shape and of a conductive material such as copper foil having a sheet thickness of 0.01 inches for typical thickness, but need not be limited thereto. For a given wavelength (λ) of operation external dimensions of antenna foil 10 are 1/5 λ in length by 3/50 λ in width. Parallel slots 16 and 18 are formed within antenna 10 having a length of 3/20 λ and a width of 1/100 λ. A foil strip 20 of antenna 10 lies between cutout slots 16 and 18. Strip 20 may be approximately 1/100 λ in width and is joined to antenna 10 at one end thereof, while the other end 22 is separated from the remainder of the antenna structure by a small space. This small space may be approximately 1/16 inch for providing an impedance gap between end 22 of strip 20 and edge 10a of the antenna foil. The 1/16 inch gap is nominal and may vary as desired. An impedance tap point 24 is positioned near end 22 on strip 20 where the voltage standing wave ratio (VSWR) of the antenna is nominally 1.5:1 or less. Radiant energy coupled to or from the antenna would be coupled from this impedance tap point.

FIG. 2 discloses a cross sectional view of FIG. 1, showing antenna foil 10 supported by dielectric 15 for attaching the antenna foil to the support structure or missile skin 12. Dielectric 15 may be of any suitable composition and thickness depending on the losses which may be tolerated by the antenna system. Typically, a polyethylene terephthalate (Mylar) or an epoxy impregnated fiber glass dielectric sheet with an appropriate adhesive on either side may be used to join the antenna foil to the support structure. As further shown in FIG. 2, a coaxial connector 30 is shown electrically joined to antenna structure 10 with the coaxial inner terminal connected to impedance tap point 24 of inner strip 20, for coupling radiant energy to or from the antenna.

The antenna response pattern of FIG. 3 was measured in the E plane and is a horizontal polarization plot of the antenna mounted on a six inch diameter missile. The omnidirectional pattern characteristic results at all angles around the antenna except for the sharp null at the rear or grounded end of the antenna. This sharp null of approximately 20°-30° width emphasizes the cardiod feature of the antenna pattern. As is obvious from inspection of FIG. 3, the pattern is in the form of a very wide beam, and the overall beam pattern is the surface of revolution of the shown pattern about the 0°-180° axis, and is thus omnidirectional. Since most telemetry receiving stations will be located broadside of a missile, reception of telemetry signals during flight of a missile with the thin sandwich telemetry antenna mounted on the surface thereof is enhanced by the pattern. Although the antenna is shown with the grounded edge toward the rear, relative positioning is a matter of choice depending on the direction from which prominent radiation is desired.

As antenna thickness becomes less, the antenna slots get closer to the surface of the support material. If the support member is conductive, such as a ground plane, reducing the thickness of the dielectric causes the antenna foil to approach the state of a single sheet or thin film transmission line. Therefore, for different thicknesses of dielectric material the slot dimensions will vary because of the proximity of a ground plane support member to the antenna and the inherent coupling between the slots. For a dielectric material of given insulation (lossiness) the slot dimensions and antenna dimensions are originally empirically determined for the operating frequency band. This is noticeably so for thin film technology where the minute change in dielectric causes the slot coupling to change. Once established, the dimensions for a given antenna are expressed in terms of the wavelength of operation λ and may be mass produced. In practical operation with missile or aircraft the coaxial connector (or other antenna coupling) shown in FIG. 2 may be externally mounted for low velocity missile usage but would be internally mounted for high velocity usage. Obviously, since the capacitance effect of the slots is affected by the proximity of a ground plane, the inductance of the center feed strip is also affected. With both effects occurring simultaneously, one tending to lengthen the slot and the other tending to shorten the slot, the initial empirical determination of antenna dimensions is required. Obviously, an antenna having a very close ground plane will have a different slot length from an antenna having
a relatively remote ground plane if they have the same operating frequency.

Although a particular embodiment and form of this invention has been illustrated, it is apparent that various modifications and embodiments of the invention may be made by those skilled in the art without departing from the scope and spirit of the foregoing disclosure. While the inventive antenna was designed primarily for use on a missile the antenna can be used on any object desired. Accordingly the scope of the invention should be limited only by the claims appended hereto.

I claim:

1. A high frequency antenna for use at a wavelength \( \lambda \), including a thin film conductive sheet having parallel rectangular slots therein, said slots being separated by an elongated strip of said conductive sheet, said elongated strip being disposed for impedance coupling of radiant frequency energy, and said slots having equal lengths of \( 3/20 \lambda \) and equal widths of \( 1/100 \lambda \).

2. An antenna as set forth in claim 1 wherein said slots are joined at one end by a gap which separates one end of said elongated strip from the remainder of the conductive sheet, and wherein the thin film dimensions are not more than \( 1/5 \lambda \) in length and \( 3/50 \lambda \) in width.

3. A high frequency antenna as set forth in claim 2 wherein said antenna is comprised of a copper foil not more than 0.01 inches thick.

4. The antenna as set forth in claim 3 wherein said elongated strip is approximately the same width as said slots.

5. A high frequency transmitting and receiving antenna system for substantially conforming to the configuration of supporting substrate and comprising: a conductive foil antenna having parallel slots therein for receiving and transmitting radiant energy, said slots having equal lengths of \( 3/20 \lambda \) and equal widths of \( 1/100 \lambda \), thin film dielectric support means bonded to one surface of said conductive foil, a substrate support means and ground plane attached to said dielectric film and coupled to a portion of said antenna foil.

6. An antenna system as set forth in claim 5 and further comprising an elongated strip of said antenna foil being disposed between adjacent slots for coupling radiant energy thereto and thereby developing radiant energy across said slots.

7. An antenna system as set forth in claim 6 wherein said substrate ground plane is the outer surface of a missile and said antenna foil is fixably disposed along a contoured surface thereof for radiating or receiving energy from a selected direction with respect to the missile axis.