

Dec. 20, 1966

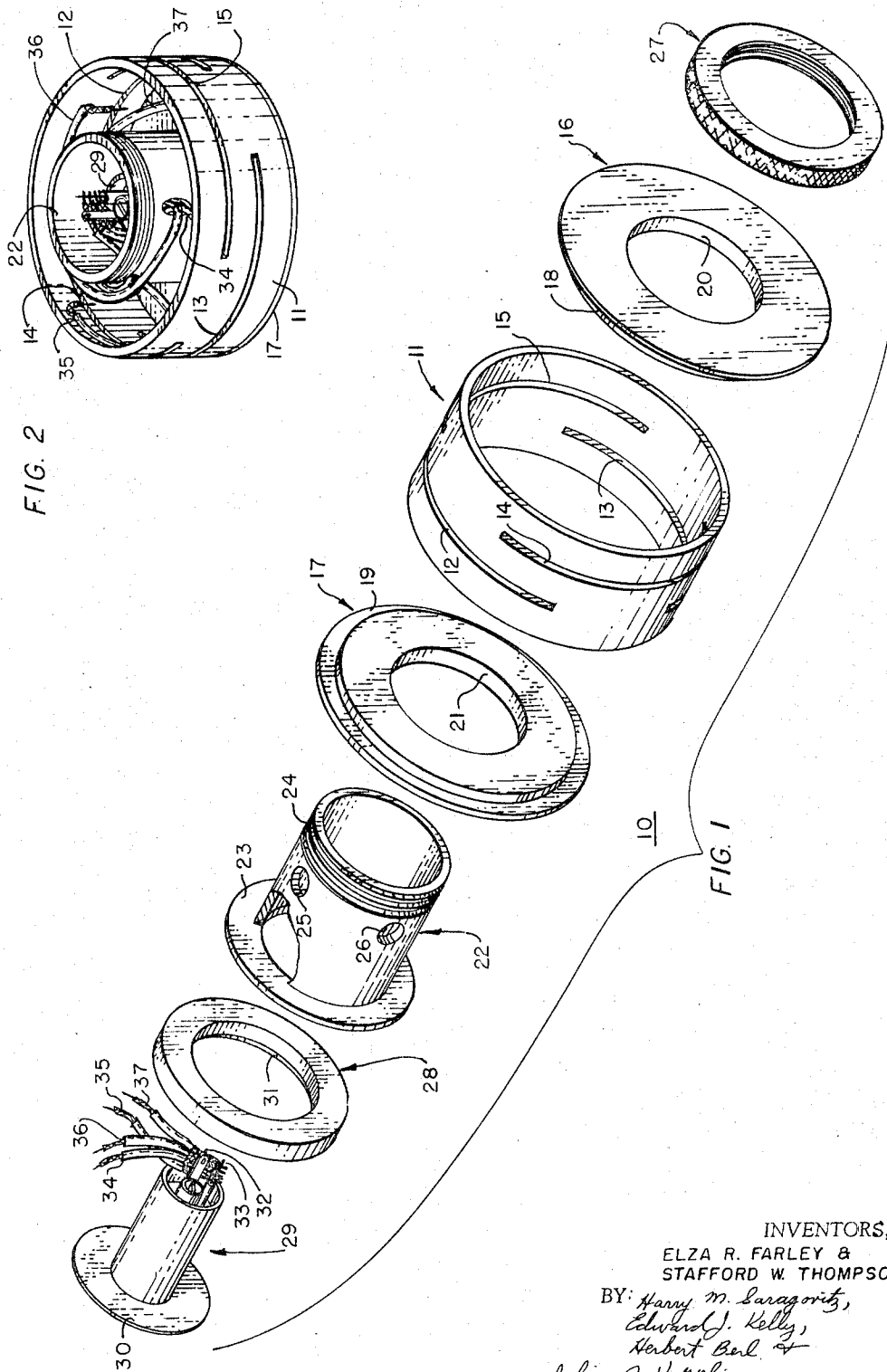
E. R. FARLEY ETAL

3,293,645

SLOTTED CYLINDRICAL ANTENNA

Filed July 9, 1964

2 Sheets-Sheet 1



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FIG. 3

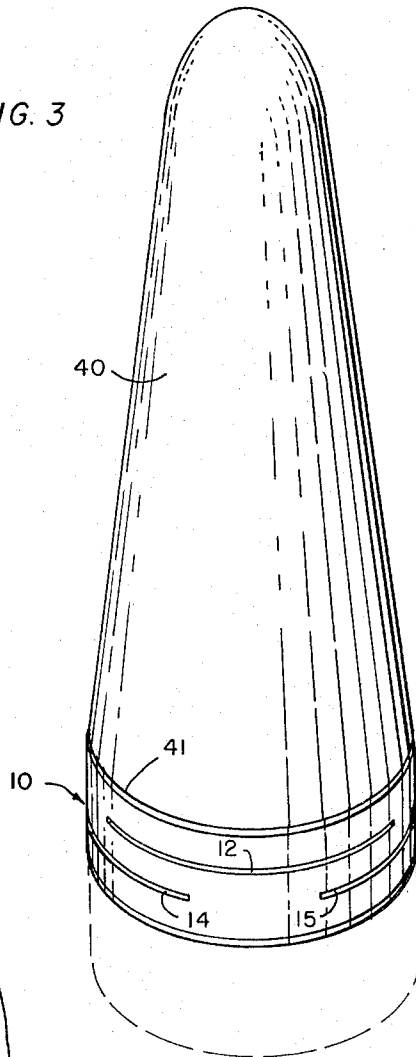


FIG. 4

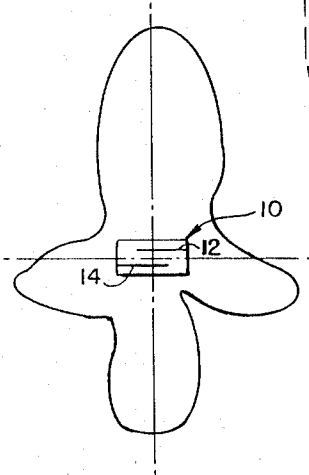
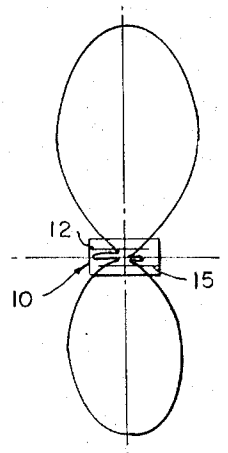


FIG. 5



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SLOTTED CYLINDRICAL ANTENNA

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13 Claims. (Cl. 343-708)

The invention described herein may be manufactured and used by or for the Government for governmental purposes without the payment of any royalty thereon.

The present invention relates generally to antennas and more specifically to an improved end-fire antenna for use on a missile.

Those concerned with the development of missiles or more specifically radiosonde nose cones have long recognized the need for low-profile, compact antennas which are capable of end-fire radiation. End-fire radiation is necessary so that the missile may be tracked while ascending and more important that tracking may be possible during descent while the nose cone is suspended "nose down" from a parachute or balloon. The low-profile feature is important for aerodynamic reasons, while the compact feature will provide for lighter nose cones or more room in the nose cone for other equipment.

One of the principal objects of the present invention, therefore, is to provide an antenna for an aerial missile, which will be capable of end-fire radiation.

Another object of the invention resides in the provision of an antenna for an aerial missile which will be mounted flush with the surface of said missile so as not to increase air drag thereon.

A further object of the invention is to provide a missile antenna which is characterized by extreme simplicity of design and which will occupy a minimum amount of space on the missile.

Other objects and many of the attendant advantages of this invention will be appreciated readily as the same becomes understood by reference to the following detailed description, when considered in connection with the accompanying drawings, in which:

FIG. 1 shows an exploded view of the antenna;

FIG. 2 shows an oblique view of the antenna shown in FIG. 1;

FIG. 3 shows the antenna mounted on a typical nose cone; and

FIGS. 4 and 5 represent radiation patterns obtained from a particular antenna designed in accordance with the present invention.

Referring now to the drawings, wherein like reference characters designate like or corresponding parts throughout the several views, there is shown in FIG. 1 an antenna 10 having an outer metallic cylinder 11 provided with four narrow circumferential slots 12, 13, 14, and 15. Slots 12 and 13 are arranged on opposite sides of cylinder 11 and lie in a plane which is perpendicular to the axis of the cylinder 11. Slots 14 and 15, which are spaced in quadrature to slots 12 and 13, lie in a second plane which is spaced a short distance from and is parallel to the plane of slots 12 and 13. Spacing the groups of slots in separate planes permits the total length of the slots to exceed the circumference of the cylinder 11. A pair of cover plates 16 and 17 having outer flanges 18 and 19, and central openings 20 and 21 respectively, are provided on either end of cylinder 11. A metallic inner cylinder 22 having a flange 23 on one end and a threaded portion 24 on the other end is slidably inserted through openings 21 and 20. Also provided on cylinder 22 are radial openings 25 and 26. The threaded portion 24 when as-

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sembled will extend beyond cover plate 16 and mate with knurled nut 27. Flange 23 will engage plate 17 while nut 27 will be snugly screwed down against cover plate 16. A dielectric spacer ring 28 is connected to the flange 23. A tubular transmitter housing 29 having a flange 30 on one end is inserted in cylinder 22. Flange 30 engages a groove 31 on ring 28. Mounted in housing 29 is the transmitting network (not shown). Extending out of one end of housing 29 are terminals 32 and 33 for connection to four coaxial lines 34, 35, 36, and 37. The center conductors of the coaxial lines are connected to terminal 33 while the outer conductors are connected to terminal 32. These terminals 32 and 33 are connected at their other ends to the proper points of the transmitting network mounted in housing 29. Coaxial lines 34-37 pass through openings 25 and 26 and are each connected across the center of a separate one of each of the slots 11-14. The coaxial lines 34 and 35 are of equal length and are connected to slots 13 and 14 respectively. Coaxial lines 36 and 37, which are also equal in length to each other, but are longer than coaxial lines 34 and 35, are connected to slots 12 and 15 respectively. The difference in length between the coaxial lines is some multiple of a half wavelength at the operating frequency such that slots 13 and 14 which are fed in phase are fed 180° out of phase with slots 12 and 15.

The outer diameter of the cylinder 11 may be chosen to be equal to the diameter of the base portion 41 of a typical nose cone 40. The antenna may be mounted to the base 41 with the slots 12 and 13 arranged proximal to the base 41. In this way the power supply (not shown) which is usually located in the nose cone 40 may be connected directly to the transmitter located in housing 29.

The antenna 10 will radiate predominantly along the axis of the cylinder since the slots 12 and 15 on one side of the cylinder 11 are fed in anti-phase with the slots 13 and 14 on the other side. The currents generated on the cylinder, which is relatively short in the axial direction as compared to a wavelength, will create an electric field distributed across the cylinder in a plane perpendicular to the axis of the cylinder. This electric field will then radiate out in a direction which is perpendicular to this plane, i.e., in the axial direction. The direction of the electric field across the cylinder 11 will generally be polarized from the side of the cylinder 11 containing the one pair of slots fed in phase to the side containing the slots fed in anti-phase thereto. It is to be noted that all slots being of equal length are dimensioned to be resonant at the operating frequency.

In a particular device built and tested the patterns shown in FIGS. 4 and 5 were obtained. The pattern of FIG. 4 is measured with the cylinder 11 oriented as shown and with the plane of polarization lying in the plane of the paper. The two predominant lobes extend up and down in an axial direction while two broadside lobes are shown substantially perpendicular thereto. These broadside lobes are a result of the electric fields generated in the slots on opposite sides of the cylinder. However, the pattern seen in FIG. 5 which was measured in a plane in quadrature to the pattern of FIG. 4 has substantially two walls on the broadside as a result of the electric fields being canceled out where adjacent slots overlap and are fed in anti-phase. The particular antenna which provided these patterns had a cylinder length of 1.5 inches which is approximately $.2\lambda$ where λ equals the wavelength at 1680 mc. The outer diameter was four inches ($.57\lambda$) while the circumferential slots were $.6\lambda$ long. The inner cylinder 22 formed a cavity $.25\lambda$ in depth.

It can therefore be seen from the above design that

by simply feeding a first group of adjacent slots, e.g., all slots on one side of the cylinder, in anti-phase to the remaining slots, i.e., the opposed slots on the other side, end-fire radiation in both directions along the axis of the cylinder is obtained. These slots which may be overlapped will not be restricted in length which will provide for lower frequencies of operation and smaller antenna diameters. If the missile should be larger or the frequency higher one need only add in a symmetrical manner additional slots and feed those on opposite sides of the missile in anti-phase. Obviously, many other modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood, that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. A slotted cylinder antenna comprising a short metallic cylinder having a plurality of circumferential slots provided therein, said slots arranged in planes perpendicular to the axis of said cylinder, and means for feeding a first group of adjacent slots in phase and for feeding the remaining of said slots in anti-phase with said first group of slots.

2. The antenna according to claim 1 and wherein each of said slots is resonant at the operating frequency.

3. The antenna according to claim 1 and further including means providing a cavity inside said cylinder and in back of said slots.

4. The antenna according to claim 2 and wherein said means providing said cavity includes a hollow metallic cylinder mounted inside and coaxially with respect to said short metallic cylinder.

5. A slotted cylinder antenna comprising; a short metallic cylinder having two pairs of opposed circumferential slots provided therein; the total length of said slots being more than the circumference of said cylinder; the slots of each of said pair lying in common planes which are perpendicular to the axis of said cylinder, said common planes of said pairs being spaced relatively close to each other; said pairs of opposed slots being arranged in quadrature about said cylinder; and means for feeding one said slot of each said pair in phase and the other said slot of each said pair in anti-phase with said one said slot of each said pair.

6. The antenna according to claim 5 and wherein each said slot is resonant at the operating frequency of said antenna.

7. The antenna according to claim 5 and further including means providing a cavity inside said cylinder and in back of said slots.

8. The antenna according to claim 7 and wherein said means providing said cavity includes a hollow metallic cylinder mounted inside and coaxially with respect to said short metallic cylinder.

9. In a missile, a slotted cylinder antenna surrounding said missile, the peripheral wall of said cylinder being flush with the outer wall of said missile and having a series of spaced peripheral slots provided therein, said slots arranged in planes perpendicular to the axis of said cylinder, and means for feeding a first group of adjacent slots in phase and for feeding the remaining of said slots in anti-phase with said first group of slots.

10. The antenna according to claim 9 and wherein said slots are resonant at the operating frequency.

11. The antenna according to claim 10 and wherein the total length of said slots is greater than the circumference of said cylinder.

12. The antenna according to claim 11 and wherein the number of slots in said first group is equal to the number of remaining slots and are arranged symmetrically around said cylinder.

13. The antenna according to claim 12 and wherein said means for feeding said slots comprises a plurality of coaxial transmission lines each connected across the center of a separate one of said slots, the difference in length between said coaxial lines connected to the slots of said first group and the remaining coaxial lines being equal to a multiple of a half wavelength at the operating frequency.

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