United States Patent

Bailey et al.

[15] **3,638,224**

[45] **Jan. 25, 1972**

[54] STACKED ARRAY OF OMNIDIRECTIONAL ANTENNAS

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[73] Assignee: **The United States of America as represented by the Administrator of the National Aeronautics and Space Administration**

[22] Filed: **Apr. 24, 1970**

[21] Appl. No.: **31,703**

[52] **U.S. Cl.** **343/771**, 343/893

[51] **Int. Cl.** **H01q 13/10**

[58] **Field of Search** 343/767–771, 893

[56] **References Cited**

UNITED STATES PATENTS

2,455,224	11/1948	Buchwalter et al.	343/769
2,744,249	5/1956	Shively et al.	343/770
2,971,193	2/1961	Siukola	343/770

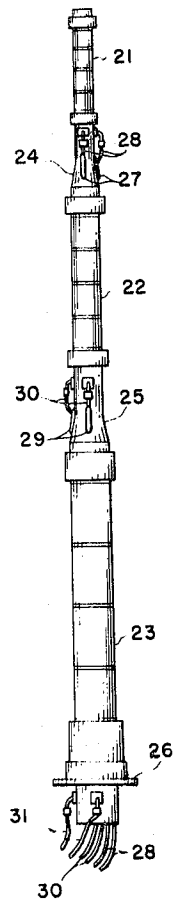
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[57] **ABSTRACT**

A stacked vertically polarized collinear array of a plurality of independently fed omnidirectional antennas operating at different frequencies. Each antenna consists of an array of five circumferential slots in the outer conductor of a dielectric filled shorted coaxial transmission line with a hollow center conductor for feed leads to pass through.

3 Claims, 3 Drawing Figures



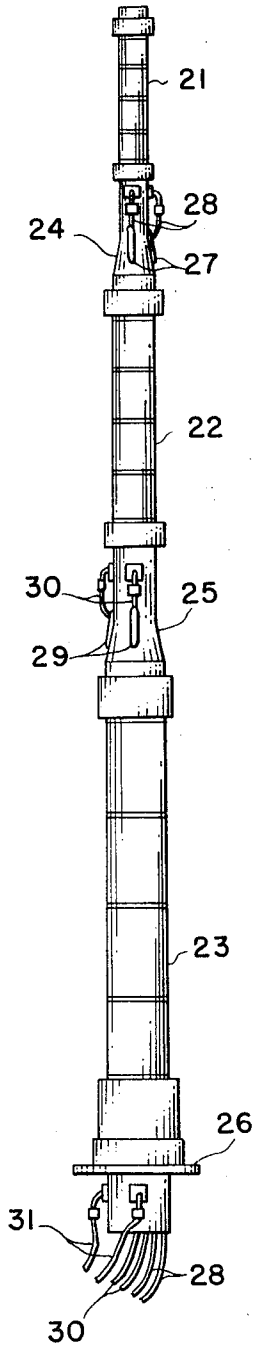


FIG. 2

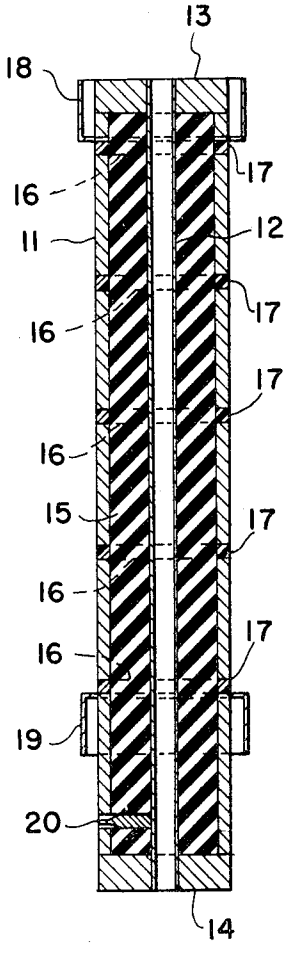


FIG. 1

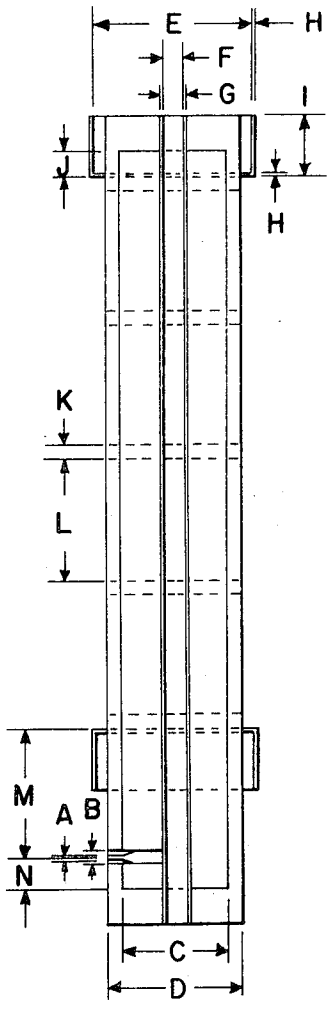


FIG. 3

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STACKED ARRAY OF OMNIDIRECTIONAL ANTENNAS

ORIGIN OF THE INVENTION

The invention described herein was made by employees of the United States Government and may be manufactured and used by or for the government for governmental purposes without the payment of any royalties thereon or therefor.

BACKGROUND OF THE INVENTION

The invention relates generally to antennas and more specifically concerns a stacked collinear array of independently fed omnidirectional antennas.

This invention was developed for the flight testing of a three frequency Doppler radar collision warning system for use on commercial aircraft. This system utilizes a coherent, CW, Doppler technique in conjunction with directional characteristics of the antennas to help discriminate between hazardous and nonhazardous intruding aircraft. The protected aircraft is required to transmit two signals of different frequencies which are received by the intruding aircraft, which retransmits a signal at the difference frequency. Generally, the antennas for such a system are required to have a fan-type radiation pattern with uniform radiation in the azimuth plane and a 20°–30° half power beamwidth in the elevation plane.

The antenna radiation patterns required for the intruding aircraft are omnidirectional with ±1.5 db. in the yaw plane and contain a half power beamwidth of about 25° in the pitch and roll planes. System response requires a good impedance match (VSWR 1.6) for the two receiving antennas over a 5 MHz. bandwidth centered about the test frequencies (2,702.5 and 4,252.5 MHz.) and a 1 MHz. bandwidth, for the transmitting antennas, centered about the difference frequency (1,550 MHz.).

The primary purpose of this invention is to provide antennas suitable for use in the collision warning system mentioned above.

SUMMARY OF THE INVENTION

This invention consists of three independently fed omnidirectional antennas stacked in a collinear array. Each antenna consists of a dielectric filled coaxial transmission line with a uniform array of circumferential slots in the outer conductor. A sleeve balun is included on each end of each antenna for pattern control in the elevation plane and to provide some degree of isolation between antennas in the stacked array. Each antenna except the top has a hollow center conductor of sufficient size to accommodate the feed cables for all antennas above it, thus eliminating the cable interference problem usually encountered in the stacking of omnidirectional antennas. Each antenna is fed through two probes located 90° apart around the circumference by signals that are in phase.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross-sectional view of one antenna used in the collinear stacked array;

FIG. 2 is a pictorial representation of a collinear stacked array of antennas; and

FIG. 3 is a cross-sectional view of one antenna for the purpose of providing suitable dimensions of the antennas in a particular stacked array for specific frequencies.

DETAILED DESCRIPTION OF THE INVENTION

Turning now to the embodiment of the invention selected for illustration in the drawings, the number **11** in FIG. 1 designates the outer conductor and the number **12** designates the center conductor of a coaxial transmission line. Shorting caps **13** and **14** are attached to the ends of the transmission line by any suitable means such as threading them onto center conductor **12**. The space between outer conductor **11** and center conductor **12** is filled with a dielectric material **15**. Equally spaced circumferential slots **16** are cut into the outer conductor **11** and Plexiglas rings **17** are inserted into these slots to maintain correct slot widths. Baluns **18** and **19** are attached to each end of the transmission line for pattern control in the elevation plane and to provide some degree of isolation between antennas in the stacked array. A molding compound can be used as a loading material to reduce the size of the baluns and provide structural support. The excitation of the antenna is through a probe **20** connected to the center conductor **12** and another probe (not shown) connected to the center conductor **12** located 90° from probe **20** around the circumference. The cylindrical feed probes are tapered to improve the excitation efficiency.

Referring to FIG. 2, there is shown three antennas **21**, **22** and **23** stacked in a collinear array. Each of these antennas is identical to the one described in FIG. 1 except that they differ in size. Antenna **21** is attached to antenna **22** by a reducing coupling **24**, and antenna **22** is attached to antenna **23** by a reducing coupling **25**. Antenna **23** has a flange **26** attached to it for the purpose of attaching the collinear array of antenna to the surface of an object such as an aircraft. Coupling **24** has two slots **27** in it so that leads **28** connected to antenna **21** can pass through the center conductors of antennas **22** and **23**. Coupling **25** has two slots **29** in it so that leads **30** connected to antenna **22** can pass through the center conductor of antenna **23**. It is necessary that the center conductors of antennas **22** and **23** are of sufficient size to accommodate the feed leads that pass through them. Leads **31** are connected to antenna **23**, hence all leads to the antennas pass through an area below flange **26**.

FIG. 3 is a drawing of the antenna in FIG. 1 labeling the difference dimensions of the antenna. Suitable dimensions for antennas **21**, **22** and **23** for operating frequencies 4,252.5 MHz., 2,702.5 MHz. and 1,550 MHz., respectively, are shown in the following table.

Dimension (inches)	Antenna 23	Antenna 22	Antenna 21
A	0.083	0.050	0.050
B	0.280	0.162	0.162
C	2.000	1.500	1.000
D	2.400	1.800	1.200
E	3.000	2.250	1.500
F	0.398	0.291	0
G	0.500	0.375	0.250
H	0.035	0.035	0.035
I	1.635	0.928	0.590
J	0.760	0.426	0.2685
K	0.230	0.1515	0.101
L	3.270	1.856	1.175
M	3.385	1.9318	1.2255
N	0.875	0.502	0.319

The advantages of this invention are numerous and it is especially adapted for use on commercial aircraft that utilize a three-frequency Doppler radar collision warning system. It is to be understood that the form of the invention herewith shown and described is to be taken as a preferred embodiment. Various changes can be made in the shape, size and arrangement of parts. More or less than five circumferential slots could be used in each antenna; more than three of the antennas could be stacked in a linear array; and different operating frequencies than those described could be used without departing from the invention claimed in the following claims.

What is claimed is:

1. A stacked collinear array of antennas for mounting on a surface such as the outside surface of an aircraft comprising: a plurality of different frequency antennas with each antenna comprising a coaxial transmission line consisting of an outer conductor and a hollow center conductor, a dielectric material for filling the space between said outer conductor and said center conductor, shorting caps located at each of said coaxial transmission line for electrically connecting said outer conductor to said center conductor, a plurality of slots cut into

said outer conductor, and probe means for feeding each antenna; said plurality of antennas being stacked in a collinear array with adjacent antennas being attached to each other by a coupling having openings in it for electrical leads to pass through; a flange attached to the bottom antenna of said collinear array for attaching said array of antennas to said surface such that the hollow portion of the center conductor of said bottom antenna terminates below said surface; and separate electrical leads connected to said probes of each antenna with each lead passing through one of said openings in said couplings and then through the hollow of the center conductor of every antenna between said one of said openings and said surface whereby the interference problem usually encountered in the stacking of omnidirectional antennas is eliminated.

2. A stacked collinear array of antennas in accordance with claim 1 wherein each of said plurality of antennas has a sleeve balun means located near each of its ends for providing isolation between the antennas in the stacked array.

3. A stacked collinear array of antennas in accordance with claim 1 wherein said probe means for feeding each antenna includes two probes connected to said center conductor 90° apart around its circumference to be fed by in-phase signals to provide uniform excitation around the circumference of the center conductor.

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