March 12, 1968 J. J. LORENZO ETAL 3,373,434

LIGHTWEIGHT ANTENNA FORMED FROM NET OF DIELECTRIC CORD, HAVING METALIZED SECTORS THEREON

Filed Dec. 1, 1964 3 Sheets-Sheet 1

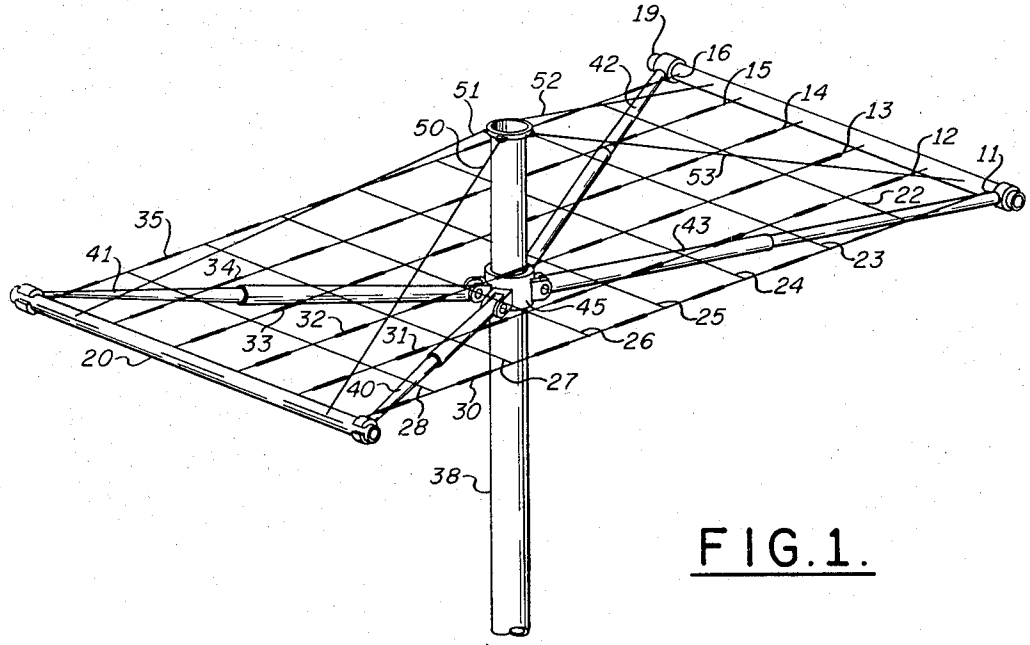

FIG. 1.

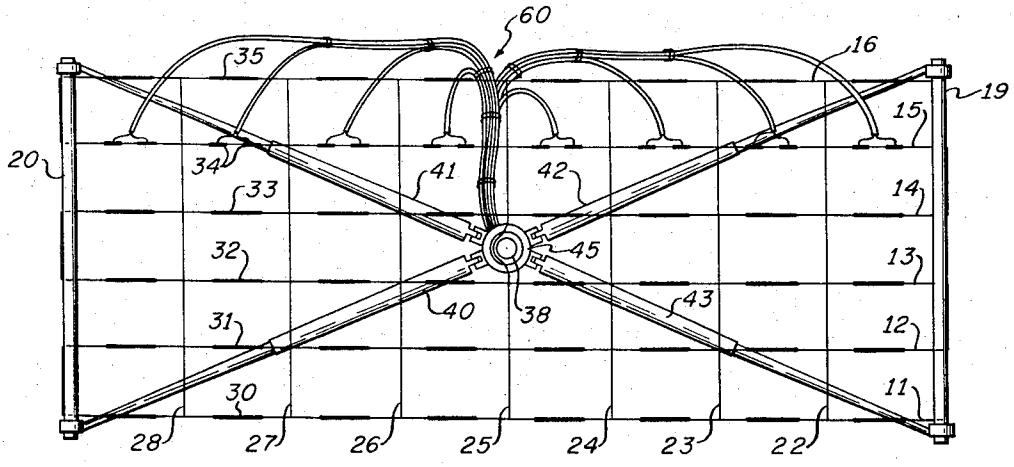

FIG. 2.

INVENTORS
JOHN J. LORENZO
GEORGE O. NAGEL
LEON SCHWARTZMAN
BY
John H. Gallagher
ATTORNEY

March 12, 1968 J. J. LORENZO ET AL 3,373,434

LIGHTWEIGHT ANTENNA FORMED FROM NET OF DIELECTRIC CORD, HAVING METALIZED SECTORS THEREON

Filed Dec. 1, 1964

3 Sheets-Sheet 2

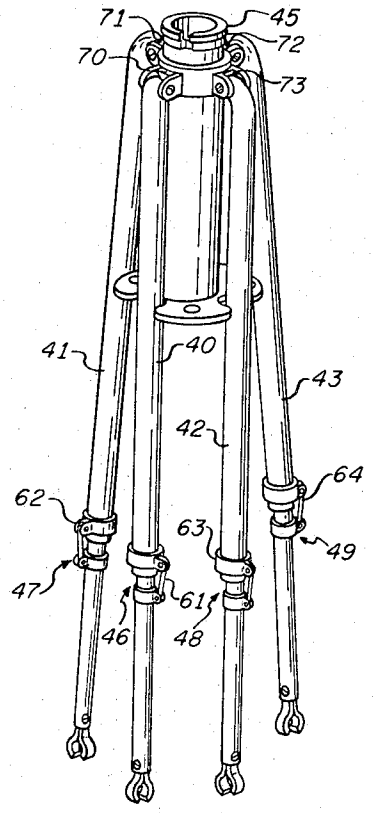

FIG. 3.

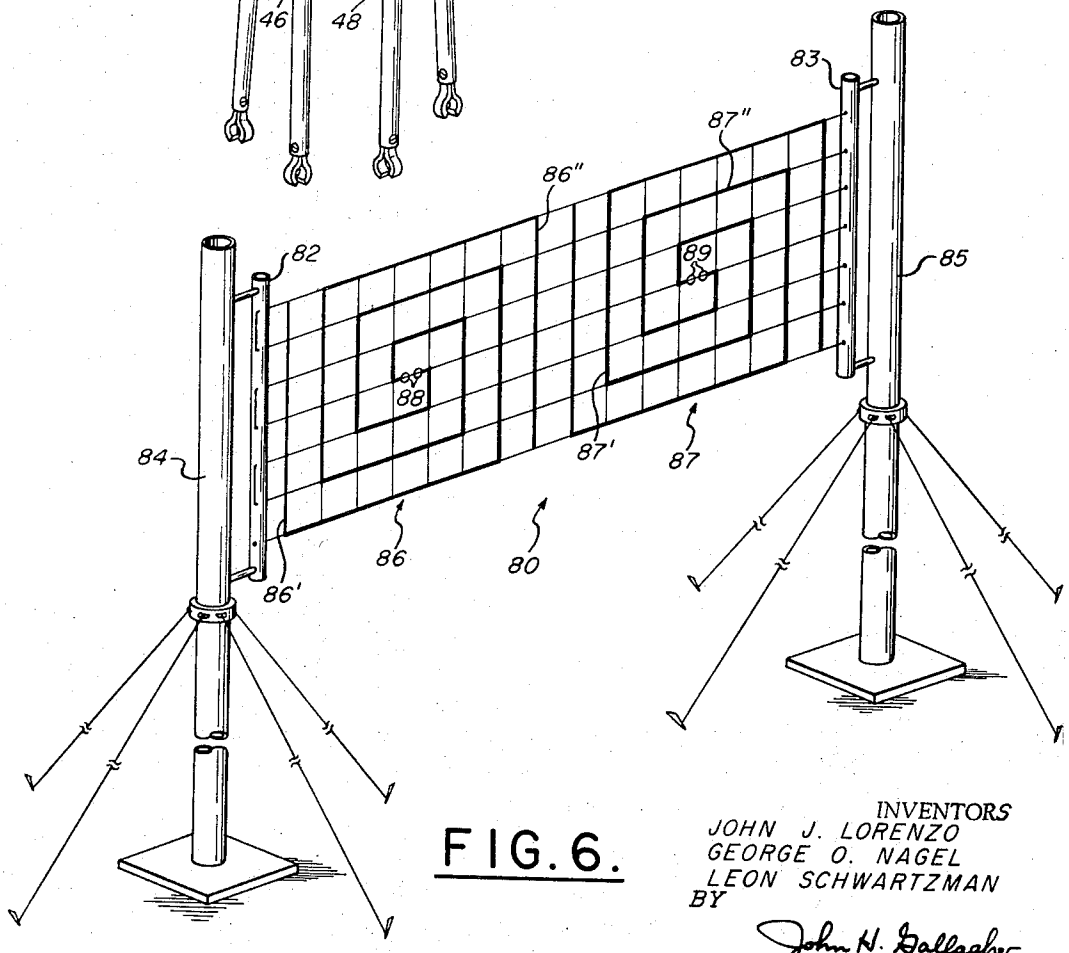

FIG. 6.

INVENTORS
JOHN J. LORENZO
GEORGE O. NAGEL
LEON SCHWARTZMAN
BY
John N. Gallagher
ATTORNEY

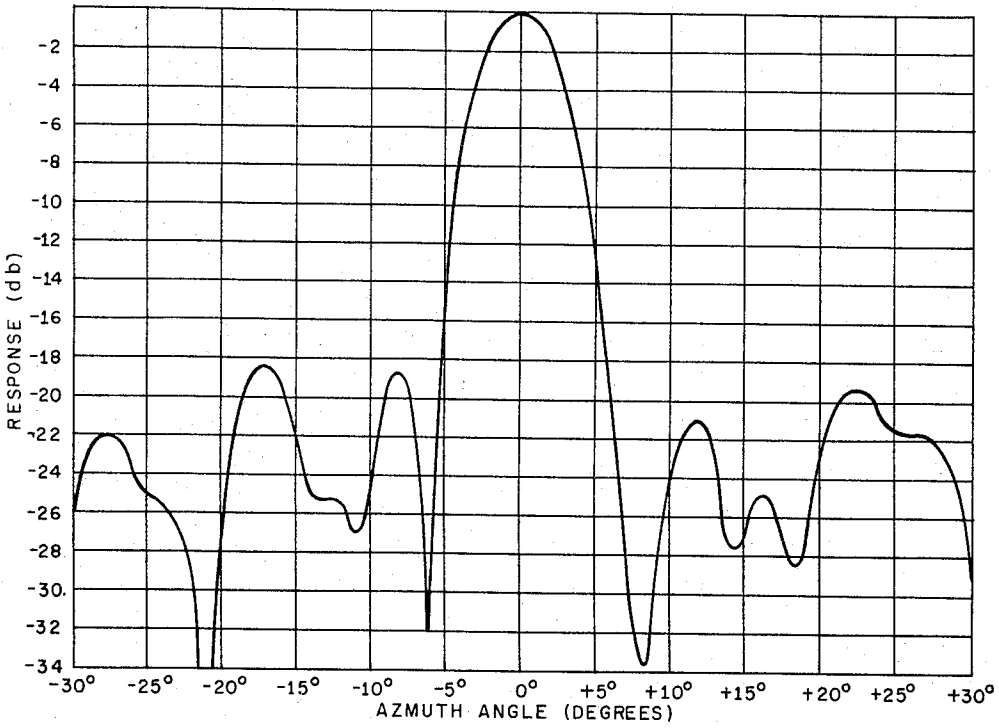

FIG. 4.

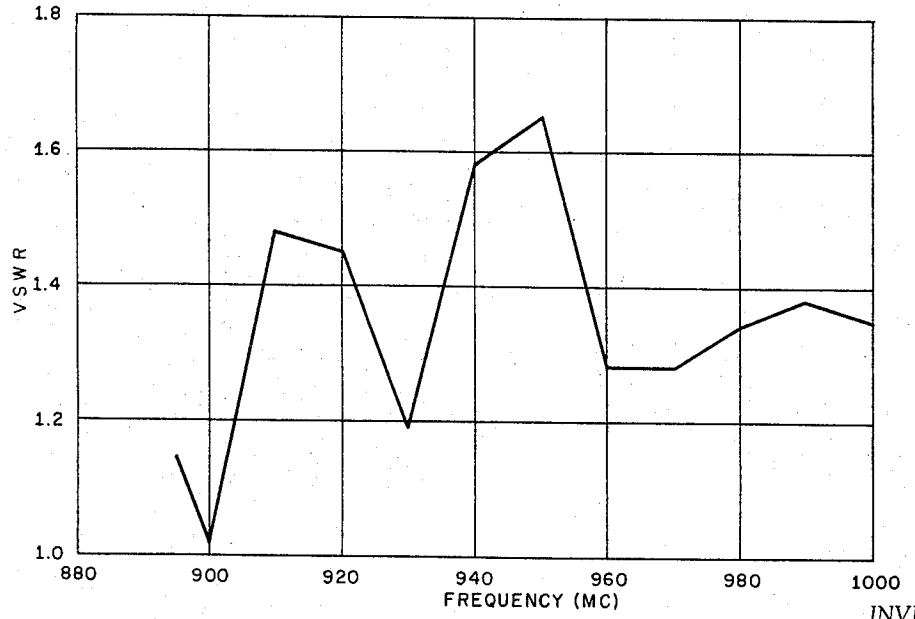

FIG. 5.

INVENTORS
JOHN J. LORENZO
GEORGE O. NAGEL
LEON SCHWARTZMAN
BY
John H. Gallagher
ATTORNEY

United States Patent Office 3,373,434 Patented Mar. 12, 1968

3,373,434

LIGHTWEIGHT ANTENNA FORMED FROM NET OF DIELECTRIC CORD, HAVING METALIZED SECTORS THEREON

John J. Lorenzo, Rosedale, George O. Nagel, Massapequa Park, and Leon Schwartzman, Brooklyn, N.Y., assignors to Sperry Rand Corporation, Great Neck, N.Y., a corporation of Delaware

Filed Dec. 1, 1964, Ser. No. 415,003
1 Claim. (Cl. 343—879)

ABSTRACT OF THE DISCLOSURE

A lightweight portable antenna having a collapsible support member comprising a net-like structure of dielectric cords. Selected ones of the cords are covered by conductive segments to provide the elements of an antenna having a shape conforming to the contour of the selected cords of the net-like support structure.

This invention relates to lightweight, inexpensive, and readily transportable antennas, and more particularly relates to multi-element antennas whose individual elements are formed by metallized segments on a plurality of lengths of dielectric cord, said metalized segments and the lengths of dielectric cord being arranged in a predetermined pattern on a suitable supporting frame to form a desired antenna array.

In the use of radio communications and radar systems, both civilian and military, it often is required that the operating location be frequently changed, and it also is often desirable that the equipment be transportable to rather remote locations that are not accessible by heavy vehicles. These factors make it desirable to have lightweight, compact and readily transportable operating equipment. In systems that utilize a shaped antenna pattern, the antenna structure required to obtain the desired pattern can become quite bulky, heavy, and require considerable time to set up and take down, thus constituting a major factor in the usefulness of the system for particular applications.

It therefore is an object of this invention to provide a lightweight, readily transportable antenna that may be set up and taken down with a minimum of effort.

Another object of this invention is to provide a multi-element antenna array which is readily transportable in small, compact, and lightweight units.

A further object of the invention is to provide a multi-element antenna array that is inexpensive to manufacture, easy to construct, and is subject to slight wind loading as compared to other known multi-element antenna arrays.

A further object of this invention is to provide a lightweight antenna that is comprised of lengths or strands of dielectric cord that are supported on a frame and provided with metalized segments that are arranged appropriately along the lengths of cords to form an array, or arrays of elements that are necessary to provide a desired antenna pattern.

These and other objects and advantages of the present invention, which will become more apparent from a reading of the following specification and claims, are achieved in an illustrated embodiment of the invention by providing a rectangularly-shaped grid or net-like arrangement of dielectric cords that are supported in a stretched-out fashion on a suitable supporting frame or structure. The lengths of cord are provided with metalized segments along their lengths, these segments being appropriately spaced and arranged to form the various elements of a particular antenna array, or an array of arrays. Various ones of the metalized segments are connected to transmission lines which provide the necessary excitation of the elements to produce the desired radiating and receiving antenna pattern. The supporting frame is secured to an antenna mast and the assembly comprises a lightweight structure that offers little wind resistance, is easily erected, and readily transportable in small lightweight packages when disassembled.

The antenna of this invention will be described by referring to the accompanying drawings, wherein:

FIGS. 1 and 2 are perspective and top views, respectively, of an antenna constructed in accordance with the present invention;

FIG. 3 is a detailed illustration of the frame or supporting structure for supporting the dielectric cords;

FIGS. 4 and 5 are graphs illustrating the antenna pattern and voltage standing wave ratio (v.s.w.r.), respectively, of an antenna constructed in accordance with the teachings of this invention; and

FIG. 6 is an illustration of an alternative embodiment of an antenna constructed in accordance wtih the teachings of this invention.

Referring now in more detail to the drawings, an antenna that successfully fulfilled the above objects is illustrated in FIGS. 1 and 2. This antenna is comprised of a plurality of Yagi antennas positioned side-by-side and excited in the proper phases to produce a desired radiation pattern. Physically, the antenna is comprised of a grid-like arrangement of dielectric cords or strands wherein the lengths of cords **11–16** are secured to the end rods **19** and **20**. To assure the maintenance of proper spacing between cords **11–16** the transversely-extending cords **22–28** are either tied to cords **11–16** or the two groups of cords may be wound together in the maner of a fish net. The cords **11–16**, **22–28** are made from a dielectric material such as Dacron or wound fiberglass that have low stretch characteristics and high tensile strengths. The end rods **19** and **20** are made of lightweight fiberglass tubing. The elements of each Yagi array are comprised of short metalized conductive segments such as the segments **30–35** on the respective cords **11–16**. The dielectric cords may be metalized at the desired segments to form the elements by crimping or bonding aluminum or copper foil to the cords, by applying adhesive metallic tape, by applying metallic paint, or by weaving metallic thread into the cord.

The net-like arrangement of the cords is supported on the antenna mast **38** in its stretched-out position by the supporting rods **40–43** which lie beneath the plane containing the cords. One end of each of the rods **40–41** is releaseably secured to an end of the end rod **20**, and their other ends are secured by means of pivot joints to a yoke **45** secured to the mast **38**. The other two supporting rods **42** and **43** are secured in like manner to support the end rod **19**. Support rods **40–43** also are made of fiberglass tubing, and as illustrated in FIG. 3, are provided with telescoping joints **46–49**, thereby permitting the entire supporting structure to be telescoped and folded into a small, compact unit that is readily transported. Suitable locking means **61–64** are associated with the telescoping joints **46–49**.

As illustrated in FIG. 1, the net-like structure is supported from above by the dielectric cords **50–53** which extend from the top of mast **38** to the respective corners of the end rods **19** and **20**. These supporting cords also are made from a dielectric material such as Dacron or fiberglass.

Because of the extreme light weight of the antenna array, the antenna mast **38** also may be of fibergalss tubing, thus further minimizing the overall weight of the entire antenna assembly.

The driven elements of each Yagi antenna, such as the element **34**, are excited by means of a suitable connection to a section of coaxial transmission line **60**. The

driven elements may be excited from a phase and amplitude determining network to obtain the excitation that is required to produce a desired radiation pattern.

If desired, one or more similar array of Yagi antennas may be mounted below the one illustrated in FIG. 1 so as to add further beam-shaping capabilities to the antenna. The structure and means of mounting the additional arrays will be substantially identical to those described above. Because of the very light weight of the antenna structure and the openness of its structure, i.e., no large surfaces, the antenna offers very low wind resistance and therefore is physically stable even in relatively high winds when the antenna mast is properly supported by guy wires, as is conventional in the art.

The assembly and erection of the antenna array illustrated in FIG. 1 is a relatively simple matter. The various components will be separately packaged for transportation. For example, end rods **19** and **20** with the dielectric cords **11–16**, and **22–28** secured thereto may be rolled into a tight bundle. Similarly, the yoke **45** and supporting rods **40–43**, FIG. 3, will be separately packaged, as will the sections of antenna mast **38**. In the assembly process, end rods **19** and **20** and the lengths of cords **11–16** and **22–28** will be unrolled and stretched out into their rectangular shape. The supporting rods **40–43** then are raised and extended to the approximate desired lengths. The extent to which supporting rods **40–43** may be raised is limited by appropriate stops **70–73**, FIG. 3, that are associated with the respective pivot joints that secure them to yoke **45**. Yoke **45** next is inserted over the end of the top section of mast **38** and is secured to the mast by suitable clamping means, and the end rods **19** and **20** are secured to the supporting rods **40–43**. The supporting cords **50–53** next are attached to the ends of end rods **19** anw **20** and are secured to the top of the end section of mast **38**. Final adjustments then are made to the lengths of the supporting rods **40–43** and to the supporting cords **50–53** to assure the correct planar alignment of the dielectric cords forming the antenna array and to assure that the lengths of dielectric cord are taut. The assembled antenna array then is secured to the remainder of the mast **38** and the mast is erected in the usual manner.

In practice, an antenna was constructed in the manner illustrated in FIG. 1, having a rectangular shape with dimensions of 4 feet x 12 feet, and including an array of 8 Yagi antennas, each antenna having 12 director elements and one reflector element. The elements were formed by securing aluminum tape at the appropriate positions on the dielectric cord. The excited element of each antenna was fed from a power divider network that excited the 8 antennas with a Tschebysheff amplitude distribution. The Yagi antennas were designed in accordance with standard antenna theory which is discussed in many standard texts. For operation in the L-band portion of the frequency spectrum, and with no particular attempt to maximize the antenna design, the radiation pattern that was obtained is illustrated in FIG. 4, and the measured voltage standing wave ratio (v.s.w.r.) is illustrated in FIG. 5. The entire weight of the operable array of antennas, including all hardware, mast, and transmission line feed system, was approximately 13 pounds.

It will be understood that a rectangular grid-like arrangement of the dielectric cords is not the only possible arrangement for these cords within a supporting frame comprised of the fiberglass tubing, nor is the array of Yagi antennas the only type of array that can be constructed by means of metalized segments on the dielectric cord.

Further, the radiating antennas need not be of the end-fire type as is the Yagi antenna, but broadside arrays may be constructed by supporting the lengths of dielectric cord with the metalized segments thereon in a plane that is perpendicular to the ground. An example of this latter type of array is illustrated in FIG. 6 wherein the grid or net-like pattern **80** of flexible dielectric cords is tautly supported between the end members **82** and **83**. The end members **82** and **83** in turn are supported by the masts **84** and **85**, the masts being properly supported by the guy ropes, as illustrated. The antenna array that is formed on the net-like pattern **80** is comprised, for illustrative purposes, of two spiral antennas **86** and **87**. The spiral antenna **86** is formed by the continuous conductive elements **86'** and **86''** which may be formed by applying flexible conductive tape or conductive paint, for example, along selected paths formed on the dielectric cords of the net-like pattern **80**. A transmission line may be connected to the respective elements **86'** and **86''** at the feed points **88** at the center of the spiral **86**. Similarly, spiral antenna **87** is comprised of the continuous conductive elements **87'** and **87''** which may be connected to a transmission line at the feed points **89**. The end members **82** and **83**, as well as the sections of the masts **84** and **85** may be made of lightweight fiberglass tubing, and the flexible dielectric cords of the net-like pattern **80** may be of the same materials as previously mentioned in the description of FIG. 1.

The broadside radiating array will have little wind resistance because of the very open and porous nature of the net-like pattern **80**. The net-like pattern **80** and the end members **82** and **83** may be detached from the masts **84** and **85** and may be rolled into a small and lightweight package for easy transport.

While the invention has been described in its preferred embodiments, it is to be understood that the words which have been used are words of description rather than limitation and that changes within the purview of the appended claim may be made without departing from the true scope and spirit of the invention in its broader aspects.

What is claimed is:

1. A lightweight antenna comprising

a first group of dielectric cords disposed in a common plane in parallel-spaced apart relationship,

a second group of dielectric cords disposed in said common plane in parallel-spaced apart relationship and extending transversely to said first group,

said two groups of cords intersecting each other and being secured together at their points of intersection to form a net-like structure, and

conductive segments placed along respective cords of said net-like structure to provide the elements of an antenna having a shape conforming to the contour of said respective cords.

References Cited

UNITED STATES PATENTS

1,683,270	9/1928	Taylor et al.	343—897 X
2,412,562	12/1946	Crawshaw	343—897 X
2,667,577	1/1954	Graziano	343—897 X
2,866,195	12/1958	Powlison	343—700
3,047,860	7/1962	Swallow et al.	343—915 X
3,129,427	4/1964	Dunlavy	343—895 X
3,152,330	10/1964	Chatelain	343—895 X
3,276,027	9/1966	Bell et al.	343—886 X

HERMAN KARL SAALBACH, *Primary Examiner.*

W. H. PUNTER, *Assistant Examiner.*