United States Patent
Stropki

[15] **3,656,168**

[45] **Apr. 11, 1972**

[54] **SPIRAL ANTENNA WITH OVERLAPPING TURNS**

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[73] Assignee: **North American Rockwell Corporation,** El Segundo, Calif.

[22] Filed: **May 25, 1971**

[21] Appl. No.: **146,819**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 856,283, Sept., 1969, abandoned.

[52] **U.S. Cl.** 343/895
[51] **Int. Cl.** H01q 1/36
[58] **Field of Search** 343/895, 908

[56] **References Cited**

UNITED STATES PATENTS

3,509,465 4/1970 Andre et al. 343/895

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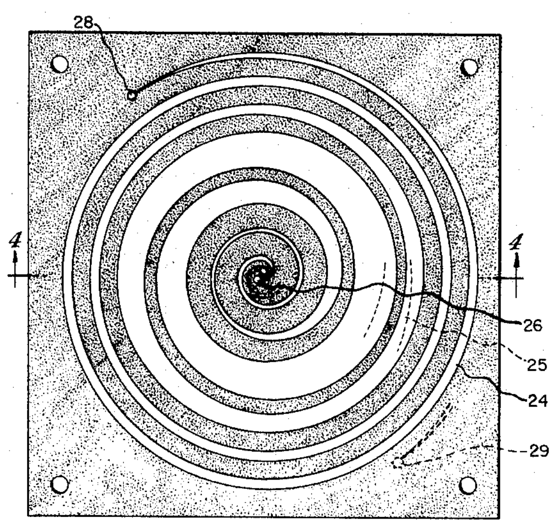
[57] **ABSTRACT**

An antenna of the type that radiates a circularly polarized electromagnetic energy field is constructed with one of an included pair of transversely overlapping double-wound spiral conductors secured to a different one of substantially parallel opposite surfaces of a dielectric support means. The improved broad band antenna radiates energy in the range of approximately 2 to 17 GHZ without radiation pattern degradation at higher peak power values in comparison to conventional circularly polarizing antennas.

2 Claims, 6 Drawing Figures



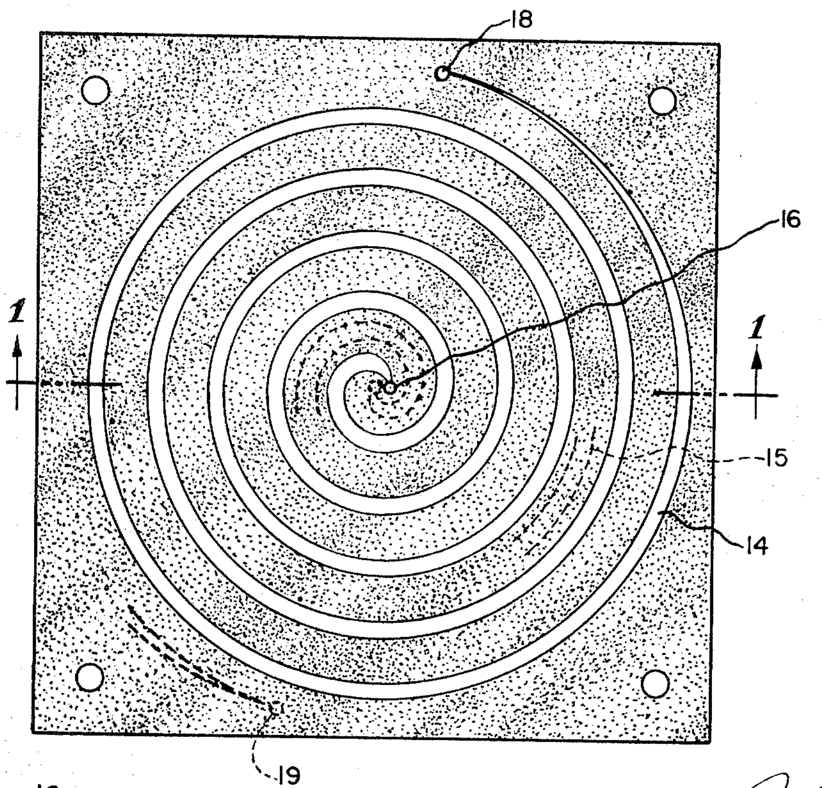


Fig. 2

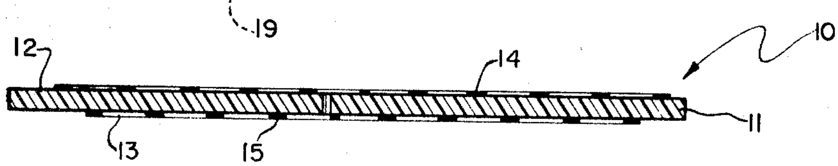


Fig. 1

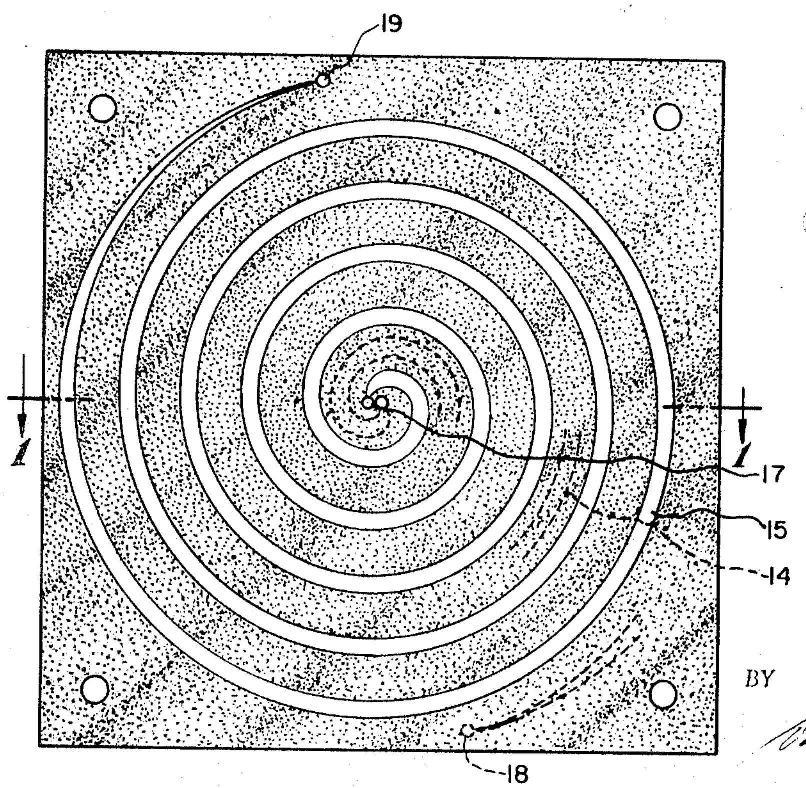


Fig. 3

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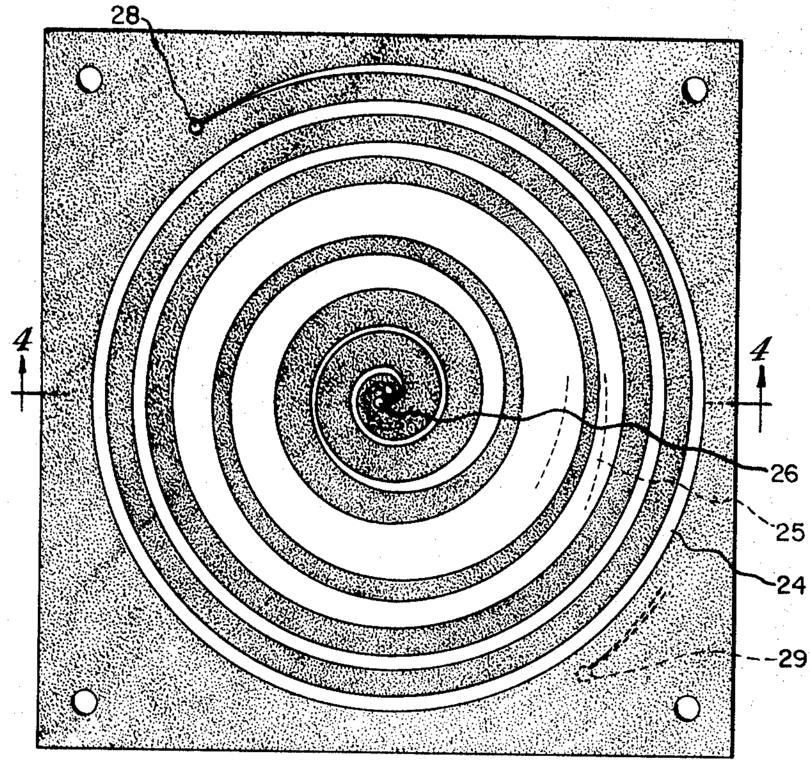

Fig. 5

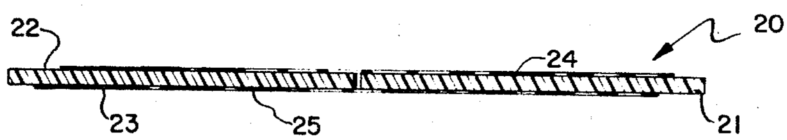

Fig. 4

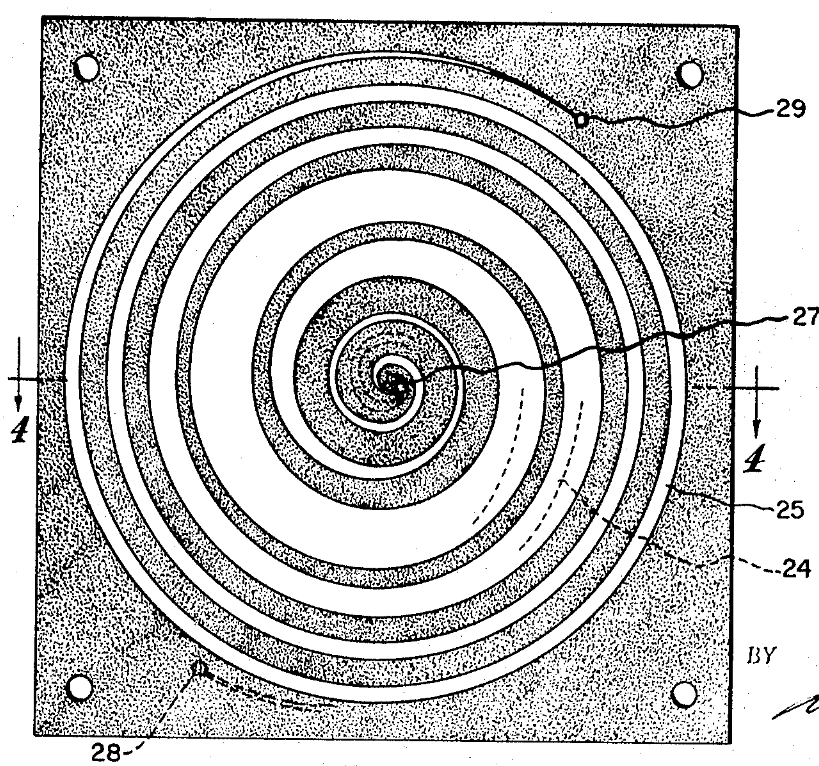

Fig. 6

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CROSS-REFERENCES

This is a continuation-in-part application of application for U.S. Pat. Ser. No. 856,283, filed Sept. 9, 1969 but now abandoned in favor of this application.

SUMMARY OF THE INVENTION

The antenna of this invention is constructed with a dielectric support member having essentially parallel opposite surfaces, such member normally being formed from a polymerized organic resin having reinforcing glass fibers or from a comparable dielectric composition. A pair of spiral metallic conductors is preferably configured on and adhered to the dielectric support member by conventional etched or printed circuit manufacturing processing or the like, each conductor being supported entirely on a different one of the parallel opposite support member surfaces. The individual conductors are each normally electrically energized from a center feed terminal by a conventional balun or coaxial feed assembly; such conductors are also normally either open-ended or sometimes terminated at a perimeter terminal to a conventional matching circuit. The individual conductors also are closely spaced in their transverse projected relationship relative to each other to provide a reduced axial ratio antenna operating characteristic, are energized by high frequency (2 to 17 GH_z) alternating electrical currents that amplitude-wise are continuously 180° out of phase with respect to each other at the feed terminals, and are geometrically developed and positioned at the opposite surfaces of the dielectric support member so that the alternating currents in the projected adjacent turns radiate a circularly polarized field from 180° out of phase electrical currents. The antenna of this invention is constructed in a manner whereby each of the conductors at the opposite surfaces of the assembly is positioned in an overlapping transverse projected relationship relative to the conductor at the opposite surface to thereby significantly improve the impedance of the antenna for impedance matching purposes.

SUMMARY OF THE DRAWINGS

FIG. **1** is a sectional view of a flat double-wound spiral antenna having the biplanar conductor features of this invention;

FIGS. **2** and **3** are plan views of the antenna of FIG. **1** showing the conductor configurations at the opposite surfaces of the antenna dielectric support means;

FIG. **4** is a sectional view of a flat double-wound spiral antenna having the features of this invention but with individual conductors of varying width; and

FIGS. **5** and **6** are plan views of the antenna of FIG. **4** showing the conductor configurations at the opposite surfaces of the antenna dielectric support means.

DETAILED DESCRIPTION

FIG. **1** illustrates a section through a circularly polarizing antenna **10** having flat dielectric support member **11** provided at its opposite planar surfaces **12** and **13** with metallic conductor elements **14** and **15**, respectively. In many applications, dielectric support means **11** may be a polymerized organic resin such as polytetrafluoroethylene reinforced with glass fibers or a similar composite with other organic resin material such as a polyphenylene oxide or an epoxy.

Conductors **14** and **15** are configured and adhered to the opposite surfaces **12** and **13** of dielectric support means **11** in a conventional manner as by state-of-the-art antenna design and etched or printed circuit board manufacturing techniques. As shown in FIGS. **2** and **3**, conductors **14** and **15** specifically may each have an equiangular spiral configuration wherein the conductor is also substantially of uniform width from near its centered feed terminal **16** (or **17**) to near its respective perimeter terminal **18** (or **19**). In other applications such conductors may be Archimedian spirals, for example, or may have square spiral configurations rather than essentially circular spiral configurations. The invention also has application to configurations for dielectric support member **11** other than the essentially flat, plate-like or sheet-like dielectric support member shape of the drawings. For instance, the invention has application to hollow, conically or pyramidally shaped dielectric base means since it is only critical that each one of the paired conductors be provided substantially on a different one of opposed, essentially parallel support surfaces and in transversely overlapping relationship relative to each other. Such invention in instances permits an increase in peak power handling capability from approximately 500 watts to as much as nearly 5,000 watts for the bisurface transversely overlapping conductor arrangement over the single surface conventional circular polarizing antenna construction with equivalent double-wound conductor widths, spacings, and lengths. The improvement is effected without significant radiation pattern degradation and without antenna radiation voltage breakdown.

The antenna embodiment **20** of FIGS. **4** through **6** illustrates the required conductor transverse overlap relationship that is effective to obtain a significant increase in peak power handling capability in connection with the instant invention. Such is accomplished by transversely overlapping the widths of the individual conductors **24** and **25** secured to support surfaces **22** and **23** of dielectric member **21** in the regions from feed terminals **26**, **27** to perimeter terminals **28**, **29** in the general manner shown in FIGS. **5** and **6**. As shown therein, conductors **24** and **25** each have a maximum width in a region of the conductor length nominally associated with the center frequency of the desired antenna operating band-width and the maximum width of conductor **24** considerably overlaps the edges of the transverse projected widths of the adjacent turns of conductor **25** and vice versa. In fact, except for a relatively narrow separation between adjacent edges of a conductor in a radial direction, each conductor may approach being sheet-like in its basic configuration.

This relationship is readily facilitated by the fact that the individual conductors are secured to the opposite support surfaces **22** and **23** of dielectric base means **21** and results in a significantly reduced impedance value for the antenna assembly, other construction characteristics being equal. In one specified embodiment of a circularly polarizing antenna with a square spiral configuration, the assembly impedance was reduced from 120 ohms to approximately 50 to 60 ohms by use of the varying width conductors on opposite surfaces of the dielectric base. In terms of increased peak power, for a given input power level the peak power can be further increased approximately 40 percent by the transversely overlapping conductor feature in the bisurface antenna arrangement.

The instant invention is not limited in its application to antenna constructions utilizing either uniform width or variable width conductors. More specifically, the transversely overlapping conductor relationship necessary to obtain a significant reduction in antenna impedance may also be developed with other conductor forms such as the slow wave antenna conductors shown in U.S. Pat. Nos. 3,454,951 and 3,465,346.

By incorporating the features of this invention in a circularly polarizing antenna it is possible to obtain antenna impedances to as low as approximately 50 ohms. The use of such transversely overlapping conductor features in an antenna also permits the use of simple coaxial feed devices rather than balun devices, thereby contributing further to the improved power handling capacity of the invention. It should be noted that the opposed conductors are fed with radio frequency signals that are 180° out of phase with respect to each other. At the radiation band the fields radiated from the transversely overlapping conductor sections are coupled and reinforce each other.

I claim:

1. In an antenna of the type which radiates a circularly polarized electromagnetic energy field, in combination:

a. Dielectric support means having exterior opposed essentially parallel support surface areas,

b. A pair of feed terminals that each conduct a different one of two equal-amplitude electrical currents continuously 180° out of phase with respect to each other, and

c. A pair of multiple-turn spiral conductor elements that are each electrically connected to a different one of said feed terminals and that together radiate a circularly polarized electromagnetic energy field,

each one of said pair of multiple-turn spiral conductor elements being adhered substantially entirely to a different one of said dielectric support means exterior opposed essentially parallel support surface areas, and also being positioned in substantial transversely overlapping relationship relative to each other in the principal radiating regions of the element.

2. The invention defined in claim **1**, wherein said multiple-turn spiral conductor elements are each varied in width in their length from a region near the connected one of said feed terminals to a region near an associated perimeter terminal.

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