

[54] SPIRAL ANTENNA STRIPLINE TERMINATION

3,509,495 4/1970 Morton ..... 333/22 R

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[57] ABSTRACT

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[51] Int. Cl. .... H01q 1/36

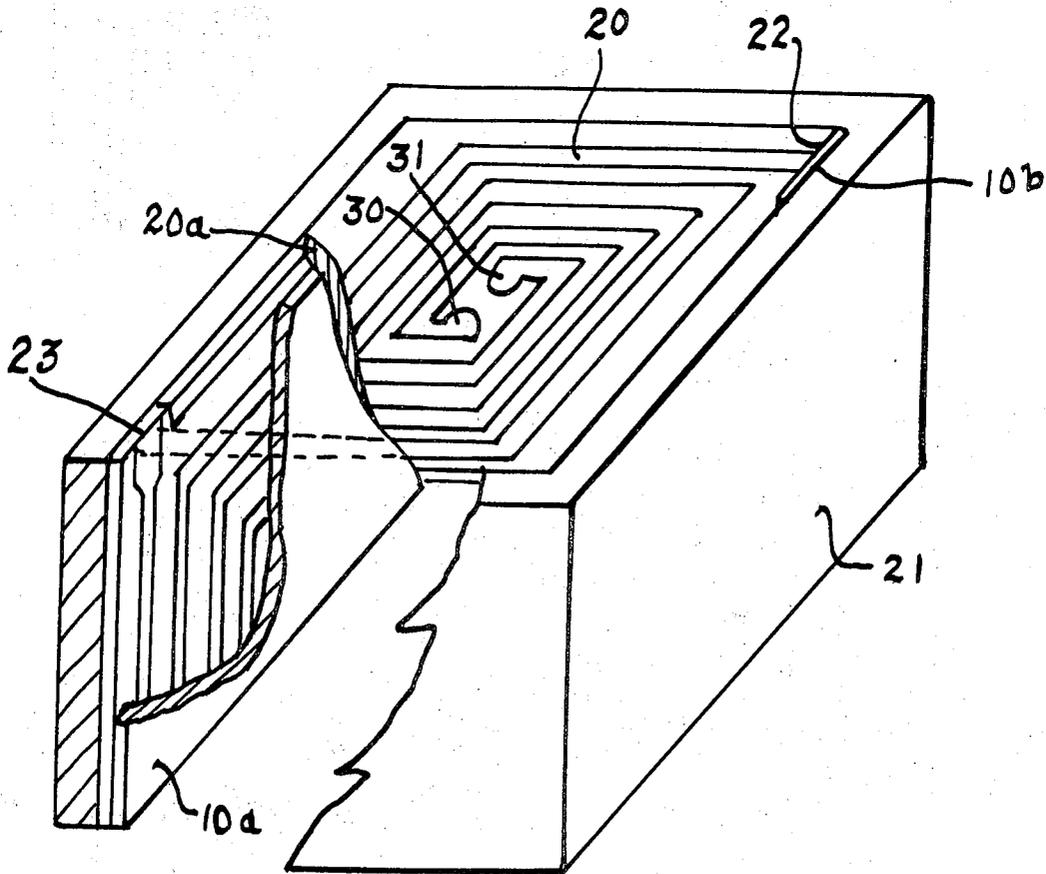
[58] Field of Search..... 343/740, 789, 895; 333/22 R

A high power stripline termination for a spiral antenna is provided wherein the termination is mounted within the cavity of the antenna. The termination is comprised of a spiraling length of transmission line etched on a lossy substrate. The spiraling line permits the use of an effectively long transmission line within a small area.

[56] References Cited  
UNITED STATES PATENTS

3,019,439 1/1962 Reis et al. .... 343/895

2 Claims, 3 Drawing Figures



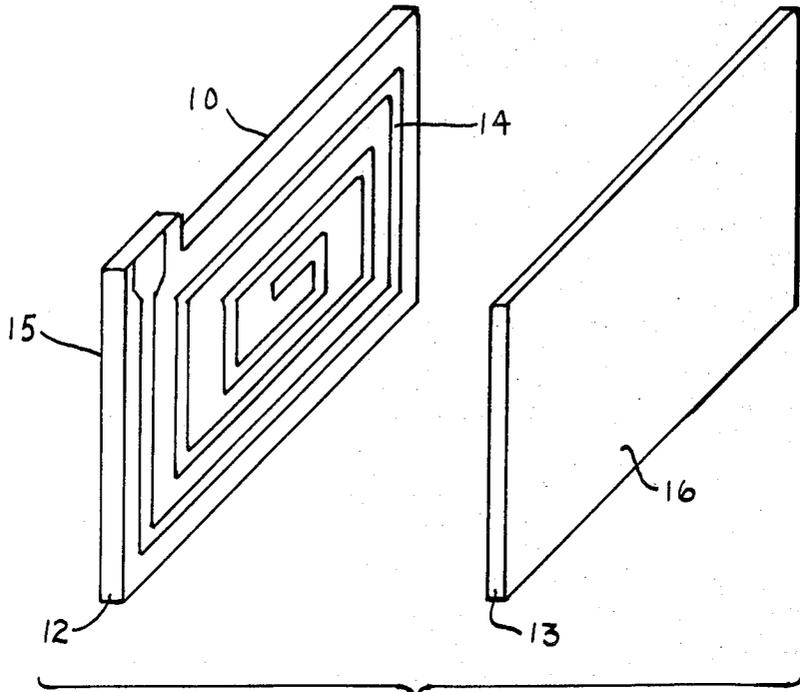


FIG. 1

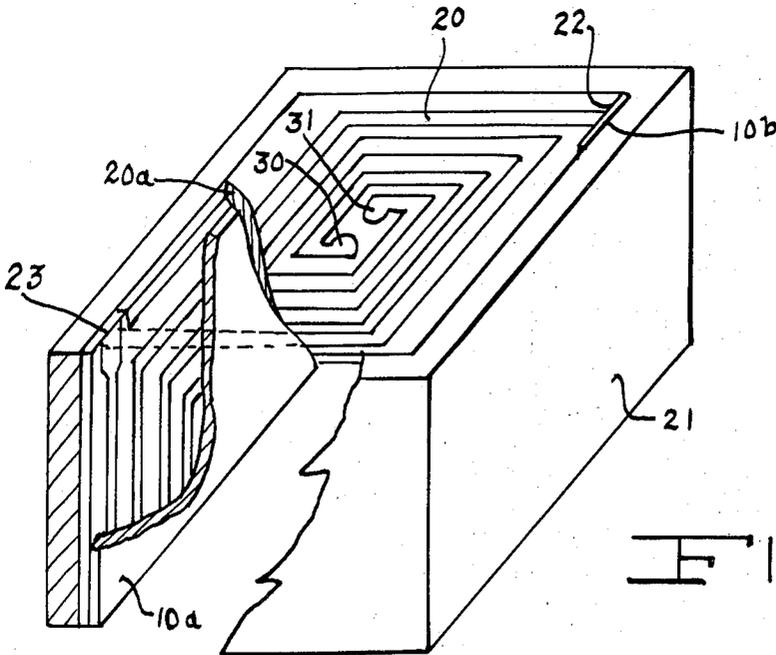


FIG. 3

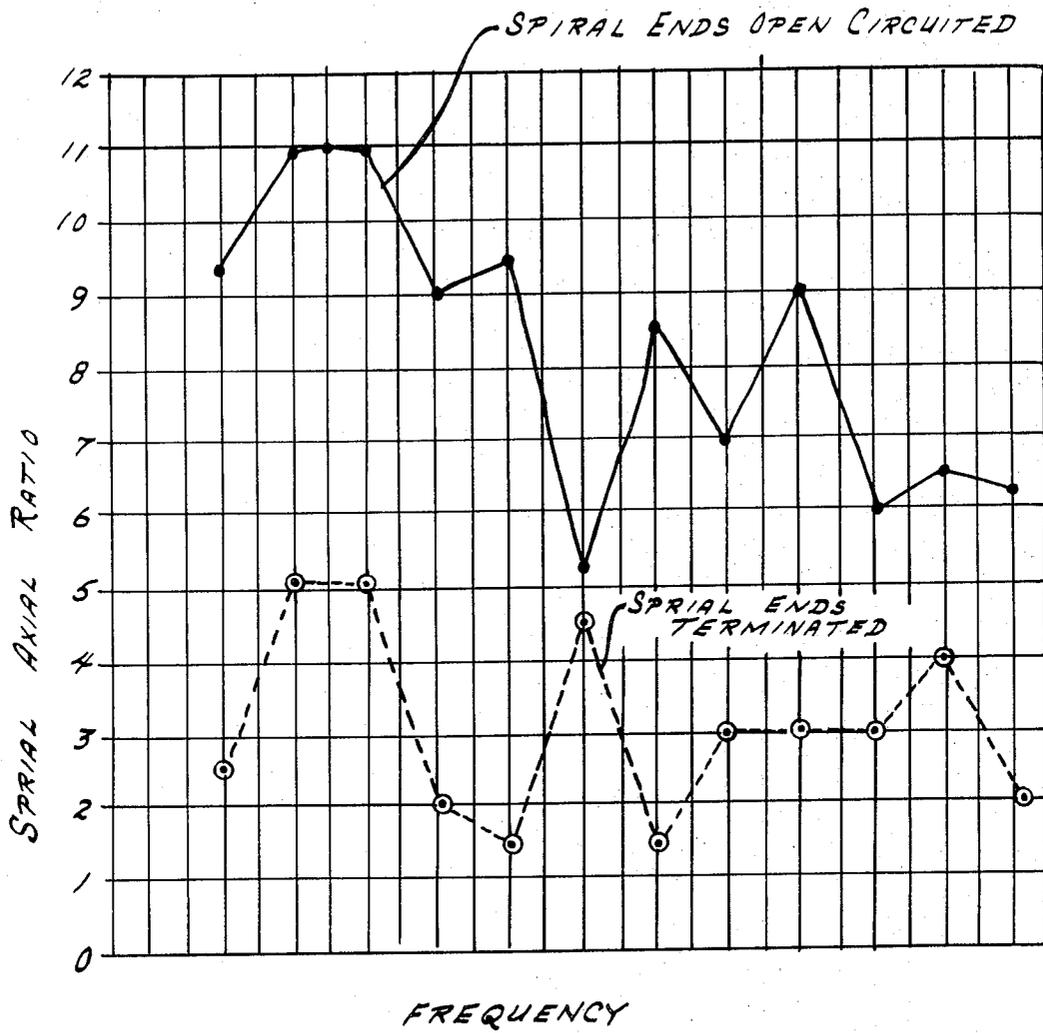


FIG. 2

## SPIRAL ANTENNA STRIPLINE TERMINATION

### BACKGROUND OF THE INVENTION

The class of antennas known as spirals have an inherent imperfect radiation efficiency which degrades the on-axis axial ratio when the spiral ends are open-circuited. Any energy which travels along the spiral and does not radiate will reach the spiral ends and undergo a complete reflection. On the return trip this energy is partially radiated, but with a polarization handedness opposite to that of the direct radiation. The effective axial ratio of the spiral is then approximately

$$\text{A.R.} = 1 + \frac{\sqrt{1-n}}{1 - \sqrt{1-n}}$$

where

$$\text{A.R.} = \text{Axial ratio,}$$

and

$n$  = Percent of spiral input power radiated. For example, if  $n = 75$  percent, the axial ratio computed from the above expression is 9.5 db (3.0).

Two basic methods are available for suppressing the reflected signal. The first utilizes a spiral etched on a lossy substrate which attenuates the direct radiation while suppressing the reflected signal. The resulting gain loss and, in the case of high CW power, localized heating, are usually intolerable. A second technique is to terminate the final turn locally with a small dab of aquadag, or a resistor. This results in a more efficient radiator but the power handling capacity is still severely limited. A more favorable method, and the subject of this invention, utilizes external loads connected to the spiral ends. These loads have little effect on the direct radiation while still suppressing the reflected signal from the ends.

### SUMMARY OF THE INVENTION

A high power stripline termination for a spiral antenna is provided. The stripline termination is comprised of a spiraling length transmission line etched on a lossy substrate to form a termination board. The spiraling line permits the use of an effectively long transmission line with a small area. Two stripline terminations serve as external loads connected to the spiral ends of the antenna. These loads have little effect on the direct radiation while still suppressing the reflected signals from the ends. The stripline terminations are mounted within the cavity of the spiral antenna.

### DESCRIPTION OF THE DRAWINGS

FIG. 1 shows one stripline spiral termination;

FIG. 2 shows curves illustrating axial ratio reduction with the spiral ends of the spiral radiator terminated; and

FIG. 3 shows a preferred embodiment of the spiral antenna with stripline spiral terminations.

### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Now referring to FIG. 1, there is shown stripline termination 10. Stripline termination 10 includes termination boards 12 and 13. Termination board 12 is shown separated from 13. In actual use, they are bonded together. The termination boards are comprised of conventional lossy substrates (dielectrics). Outer conductor surfaces 15 and 16 of termination boards 12 and 13, respectively, may be comprised of copper. The outer

surfaces may be, in one instance, copper sheets conventionally bonded (glued) to their respective termination boards. Termination board 12 has etched upon the inner surface thereof spiraling transmission line 14.

It is noted that a single stripline termination is comprised of a first lossy substrate having an outer conductive surface, and an inner surface having an etched spiraling transmission line, a second lossy substrate having an inner surface and an outer conductive surface with the inner surfaces of the first and second lossy substrates bonded (glued) together.

It is emphasized that two identical stripline terminations are required for use in the present invention.

As aforementioned, each stripline termination is comprised of a spiraling length of transmission line etched on a lossy substrate. The spiraling line permits the use of an effectively long transmission line within a small area. The end of the line at the center of the board is left open-circuited for convenience.

The length of the termination line is calculated using the expressions,

$$a = a_c + (27.3 \sqrt{\tan \delta} / \lambda)$$

$a$  = attenuation per unit length  
 $a_c$  = copper loss per unit length  
 $\epsilon\gamma$  = relative dielectric constant  
 $\tan \delta$  = loss tangent of substrate  
 $\lambda$  = free space wavelength

$$(\text{A.R.})_t = [1 + (\sqrt{1-n})|\Gamma| / 1 - (\sqrt{1-n})|\Gamma|]$$

$(\text{A.R.})_t$  = axial ratio of terminated spiral  
 $n$  = percent of spiral input power radiated  
 $\Gamma$  = voltage reflection coefficient.

For example, a measured axial ratio of 10 db (3.16) (for open-circuited spiral ends) can be reduced to about 3 db (1.41) with a termination having a reflection coefficient of 10 dbR. The required attenuation for the termination line is therefore 5 db, since any energy reflected at the end of the termination will undergo a two-way trip through the termination.

A typical axial ratio reduction using the termination type described is shown in FIG. 2. With the spiral ends open-circuited the average axial ratio is about 8 db (2.52). With the spiral ends terminated, the axial ratio is reduced to about 3 db (1.41) on the average.

A termination about 1½ inches square, etched on 1/32 inch thick paper phenolic, was found to have a power capacity of about 5 watts CW. Above this power level the material became brittle and began to char. Assuming a spiral efficiency of 90 percent, the equivalent spiral input power for 5 watts dissipation in each load is 100 watts.

Now referring to FIG. 3, there is shown the spiral antenna with two stripline terminations 10a and 10b each of which is identical to the one shown in FIG. 1. The spiral antenna is comprised of conventional spiral radiator 20 on printed circuit board 20a which is integrated with spiral cavity 21. Signal cavity 21 is made of conductive material thus providing metal walls. An example of a spiral antenna including a spiral radiator and associated cavity is shown and described in U.S. Pat. No. 3,441,937 issued Apr. 29, 1969, and entitled, "Cavity Backed Spiral Antenna." It is noted that the spiral antenna described therein is in circular form whereas the spiral antenna of the present invention is rectangular in form.

Stripline terminations **10a** and **10b** are mounted within the cavity of the spiral antenna. The spiral antenna is connected to stripline termination **10b** by means of a solder connection at location **22** and to stripline termination **10a** by means of a solder connection at location **23**. Stripline terminations **10a** and **10b** can be bonded or mechanically affixed to the inside of the cavity walls. For a lightweight structure, two of the cavity walls can be formed by the aforesaid terminations. The spiral antenna feed normally received at input terminals **30** and **31** is omitted from the figure for simplicity but may be of the type described in the aforementioned U.S. patent.

It is emphasized that the spiral termination is capable of higher power dissipation than others presently used for the following reasons: two terminations are used for each radiator, each termination need only dissipate half the unradiated power; the large size of the termination results in dissipation of the power throughout a larger volume; and the flat construction of the termination permits its placement along the metal walls of the antenna cavity which then becomes a heat sink.

What is claimed is:

1. High power stripline terminations for a spiral antenna having a spiral radiator and an associated cavity comprising a spiral having first and second ends, a cavity associated with said spiral radiator, said cavity having metal walls, first and second stripline terminations, each stripline termination consisting of a first lossy substrate having an outer conductive surface and an inner surface with an etched spiraling transmission line thereupon, a second lossy substrate having an inner surface and an outer conductive surface with said inner surfaces bonded together, each of said spiraling transmission lines having a preselected axial ratio, means to mount said first and second stripline terminations within said cavity adjacent to the metal walls thereof thus also becoming a heat sink, and means to connect said first and second stripline terminations to said first and second ends, respectively.

2. High power stripline terminations as described in claim 1 wherein each of said outer conductive surfaces is comprised of a sheet of copper, said sheet being bonded to the outer surface of said lossy substrate.

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