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2,763,002

COLLAPSIBLE ANTENNA

Filed June 30, 1951

2 Sheets-Sheet 1

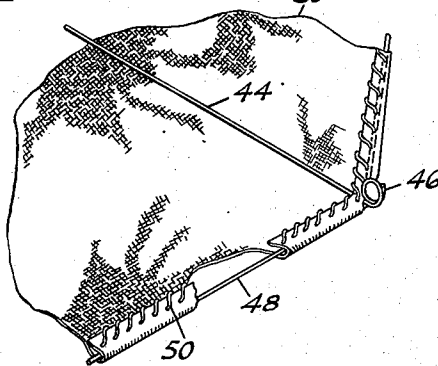
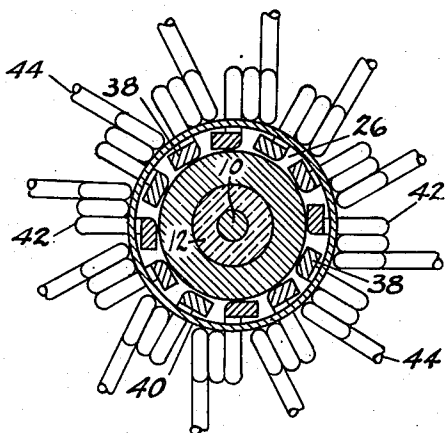
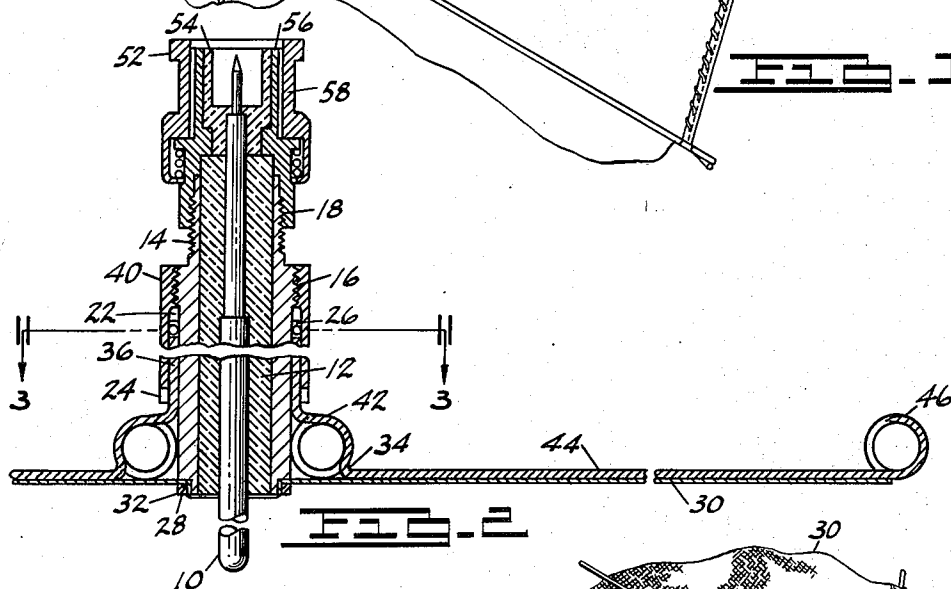
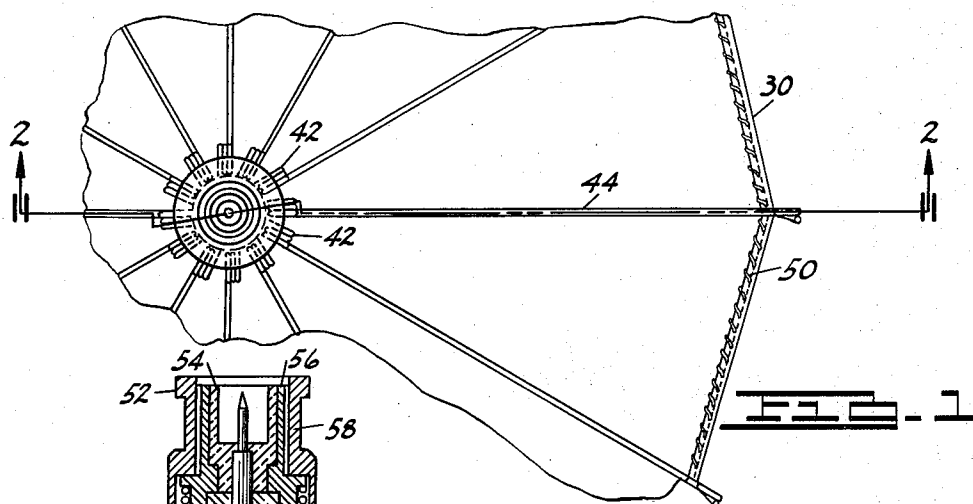


FIG. 3

FIG. 4

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FIG. 5

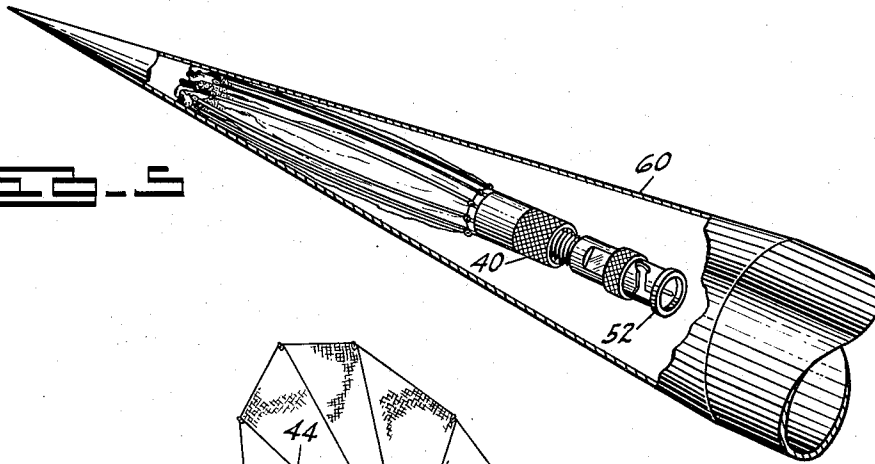


FIG. 6

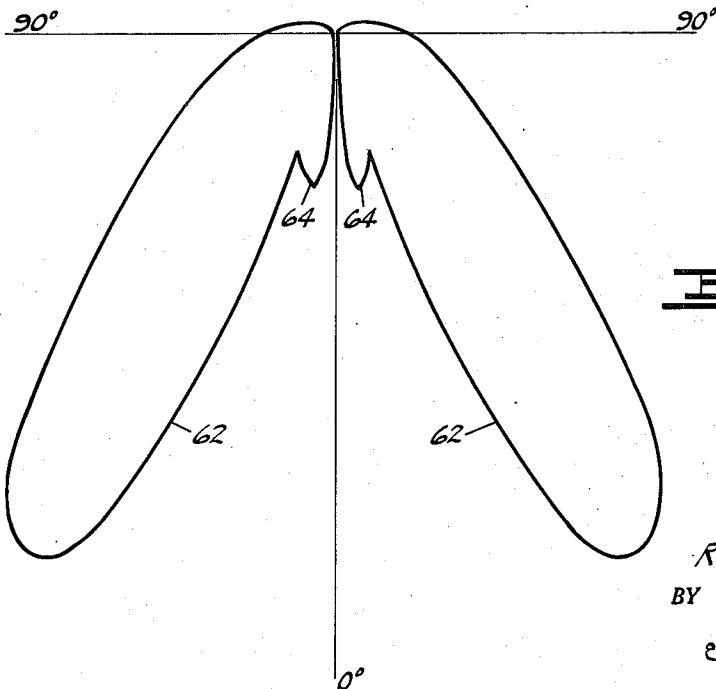
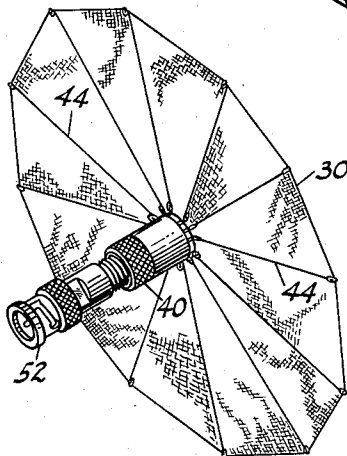


FIG. 7

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COLLAPSIBLE ANTENNA

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7 Claims. (Cl. 343—880)

This invention relates to a collapsible antenna and more particularly to a collapsible antenna adapted to provide excellent transmitting characteristics during use and to fold into a minimum space when not in use.

In many applications involving the transmission and reception of signals, the antenna has an energy radiator and a reflector which surrounds the radiator and serves as a ground plane to properly direct the signals from the radiator. In many such applications, the antenna is not always in use. Because of the large space occupied by the antenna and especially by the reflector, it has been often deemed desirable to employ an antenna which can be collapsed during its periods of non-use so that it occupies a minimum amount of space. However, difficulties have arisen in providing a reflector which will serve as an efficient ground plane during its utilization periods and which can be easily and completely collapsed during the periods of non-use. Difficulty has also been experienced in providing light and compact apparatus which will efficiently fold the reflector when the antenna is not being utilized.

This invention provides an antenna having a reflector made from interwoven threads of conductive and non-conductive material. By using a clothlike material made at least partially from conductive threads, the reflector can be collapsed into a very small bundle when not in use and at the same time can operate with an energy radiator in the antenna to provide a strong and desirable pattern when expanded. The antenna also has a novel arrangement of ribs to maintain the reflector in substantially a fixed plane relative to the radiator during the operation of the antenna.

An object of this invention is to provide an antenna which is collapsible into a minimum space when not in use.

Another object of the invention is to provide an antenna of the above character having a reflector which provides, in combination with an energy radiator, an optimum radiation pattern during the operation of the antenna.

A further object is to provide a collapsible antenna of the above character having a reflector made from a clothlike material woven at least partially from conductive threads.

Still another object is to provide an antenna of the above character incorporating pliable means for maintaining the reflector in substantially a fixed plane relative to the radiator during the operation of the antenna and for permitting the reflector to be folded into a minimum space when the antenna is not in use.

Other objects and advantages will be apparent from a detailed description of the invention and from the appended drawings and claims.

In the drawings:

Figure 1 is a fragmentary top elevational view of the antenna showing in their operative position the reflector and the ribs for supporting the reflector;

Figure 2 is a sectional view substantially on the line 2—2 of Figure 1;

Figure 3 is an enlarged sectional view substantially on the line 3—3 of Figure 2;

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Figure 4 is an enlarged fragmentary perspective view illustrating in particular detail the material from which the reflector is made and the manner in which the ribs are attached to the reflector;

Figure 5 is a perspective view of the antenna with the reflector folded to occupy a minimum space;

Figure 6 is a perspective view of the antenna shown in Figure 5, with the reflector expanded to provide the desired radiation characteristics; and

Figure 7 is a curve illustrating the radiation pattern when the reflector has the shape shown in Figure 6.

In one embodiment of the invention, a cylindrical energy radiator 10 is relatively thick at one end and somewhat thinner at the other end. At its thin end, the radiator is adapted to be connected to a coaxial line (not shown) which serves as the output end of a transmitter (not shown) or other suitable equipment. An insulator 12 made from a suitable material such as a polymer of tetra-fluoro ethylene fits snugly on the radiator 10. The insulator covers only part of the radiator 10 and exposes a predetermined length of the radiator at the thick end thereof. By way of illustration, the exposed portion of the radiator 10 may have a length equal to substantially one-fourth of a wave length at the frequency of the transmitted signals.

A hollow cylindrical support member 14 fits snugly on the insulator 12. The member has two externally threaded portions 16 and 18 (Figure 2) of different diameter, the portions being separated by a shoulder. A plurality of slots 22 are provided at spaced intervals around the periphery of the member 14. The slots extend axially along the length of the member 14 from the threaded portion 16 and terminate after passing through a collar 24 on the member 14. An annular slot 26 (Figure 3) is also provided in the member 14 between the threaded portion 16 and the collar 24.

Adjacent the bottom end of the insulator 12, the member 14 has an annular portion of restricted thickness such that a shoulder 28 is formed. A reflector 30 (Figures 1, 2 and 4) having a centrally located hole slightly larger than the diameter of the restricted portion of the member 14 fits on the restricted portion and rests on the shoulder 28. The reflector 30 is pressed against the shoulder 28 by a ring 32 which is also mounted on the restricted portion of the member 14 and is secured to the member as by silver solder.

The reflector 30 may be made from a clothlike material formed completely from interwoven conductive threads or from conductive threads interwoven with non-conductive threads. For example, a lamé material may be used in which silver threads constitute the warp of the material and nylon threads constitute the woof. When silver threads are used, other components can be easily soldered to the reflector whenever necessary. By way of illustration, the reflector 30 may have a circular circumference with a radius approximately equal to at least a wave length when the exposed portion of the radiator 10 is a quarter of a wave length long and the frequency of the transmitted signals is approximately 3000 megacycles. Such an antenna, illustrated in Figure 5, is of the quarter wave type.

Ribs 34 made from pliable wire support the outer end of the reflector 30. At one end, the ribs have retaining portions 36 (Figure 2) which lie in the slots 22 and hook portions 38 (Figure 3) which extend from the slots 22 into the slots 26 to position and retain the portions 36 in the slots 22. A sleeve 40 fits snugly on the member 14 and holds the retaining portions 36 of the ribs 34 securely in position within the slots 22. The retaining portions 36 extend beyond the collar 24 and then curve outwardly through at least two complete loops 42.

Support portions 44 are provided integrally with the loops 42 and are angularly adjustable relative to the

retaining portions 36. By providing a plurality of loops 42 between the retaining portion 36 and the support portion 44, sufficient rigidity is imparted to the portions 44 so that the portions retain the reflector 30 in substantially a fixed and predetermined position relative to the radiator 10 during the operation of the antenna. In the quarter wave embodiment illustrated in Figure 6, the reflector 30 is in a plane preferably perpendicular to the radiator 10 during the operation of the antenna. The loops 42 also prevent the portions 44 from having a permanent sag relative to the portions 36 after the portions 44 have been rotated a few times from the expanded position shown in Figure 6 to the cramped position shown in Figure 5.

A loop 46 (Figures 2 and 4) is provided at the end of the support portion 44 on each rib 34. A plurality of strings 48 (Figure 4) extend through the loops 46 on pairs of adjacent ribs and hold the support portions 44 in fixed position relative to one another. Each end of the strings 48 is tied to the loop 46 through which it extends. Before the ends of each string are tied to the loops 46, however, the segment of the reflector adjacent the string is hemmed around the string at least once and a thread 50 is sewed to this segment so as to twine around the string 48 a plurality of times. In this way, each string 48 provides a backbone for the portion of the reflector bounded by the string and an adjacent pair of ribs, so that the portion of the reflector within the boundary cannot be crumbled radially inwardly or stretched radially outwardly through an appreciable distance.

An adapter 52 screws on the threaded portion 18 of the support member 14. The adapter has an inner insulator 54 (Figure 2) similar to the insulator 12, a conductor 56 mounted on the insulator and a housing 58 surrounding the conductor 56 and in electrical and mechanical contact with the conductor. The adapter 52 serves to couple the coaxial line from the transmitter to the antenna disclosed above.

The collapsible antenna disclosed above may be used in systems where signals do not have to be continuously transmitted or received. During the periods of idleness, the support portions 44 of the ribs 34 may be rotated either upwardly or downwardly through an angle of substantially 90° to fold the reflector 30. Since the reflector 30 is the largest component in the antenna and since it juts out from the other antenna components at substantially a right angle to these components when the antenna is being used, folding the reflector when the antenna is not in use minimizes the space requirements.

The antenna is especially adapted for use in systems which are idle until a predetermined moment and which operate continuously thereafter. For example, the antenna may be used with suitable electronic equipment in a meteorological rocket for measuring conditions such as air temperature and pressure from altitudes between 0 and 100,000 feet. The antenna may be housed in the rocket, illustrated at 60 in Figure 5, which is separated from the rocket body when the rocket has reached substantially its maximum height.

As the rocket head starts to fall, it moves away from the antenna and its associated electronic equipment, which floats slowly by parachute to the ground, and exposes the electronic equipment for subsequent use. By falling away, the rocket head no longer prevents the support portions 44 on the antenna ribs from expanding the reflector 30 into a plane substantially perpendicular to the radiator 10. As will be explained in detail hereinafter, expansion of the reflector 30 produces an excellent ground plane for the transmission to a central station of signals relating to air temperature and air pressure at the different altitudes.

The signals transmitted by the antenna have an excellent pattern. One reason for this, of course, is the matching of impedances between the antenna and the coaxial line from the transmitter. Another important reason is

the negligible impedance presented by the reflector at the operating frequency, especially when the frequency is in the ultra high range of approximately 50 megacycles or above. This results from the fact that the capacitance between adjacent conductive threads is sufficiently large to produce a relatively large capacitance for the reflector. For example, the reflector used in the antenna embodiment illustrated in Figures 5 and 6 has an impedance of approximately 0 ohms along the length of the conductive threads and an impedance of approximately 2 ohms in a direction transverse to the threads when the frequency of the transmitted signals is approximately 3000 megacycles.

Figure 7 illustrates the relative strength of the transmitted signals in the different directions when the antenna, and especially the reflector, has the configuration shown in the previous figures and when the reflector is made from a lamé fabric. As will be seen, a symmetrical pattern with two main lobes 62 and two side lobes 64 is produced. The side lobes 64 are produced by slightly varying the length of the exposed portion of the radiator 10 from a quarter of a wave length and is considered important in increasing the coverage of the antenna in the space directly ahead of the radiator 10. The pattern shown in Figure 7 is considered desirable when a quarter wave antenna with a solid metallic reflector is used.

By using a lamé fabric as the reflector, there is thus provided a collapsible antenna in which the collapsing apparatus is held to a minimum weight and size and is operated at a maximum efficiency. The collapsible antenna produces an excellent pattern which does not materially differ from that produced when a solid metallic material is used as the reflector. Collapsing the antenna may be desirable when it is only intermittently in use or when it remains idle until a predetermined moment and is used continuously thereafter.

Although this invention has been disclosed and illustrated with reference to particular applications, the principles involved are susceptible of numerous other applications which will be apparent to persons skilled in the art. The invention is, therefore, to be limited only as indicated by the scope of the appended claims.

What is claimed is:

1. A collapsible antenna, including, an energy radiator, a collapsible reflector formed from an interwoven combination of conductive and non-conductive threads, a support member, and a plurality of pliable ribs having first portions of finite length secured to the support member and having second portions of finite length extending from the first portions at an angle to the first portions, the second portions of the ribs being flexible with respect to the first portions of the ribs, the second portions of the ribs being secured at their extremities to the periphery of the reflector to maintain the reflector substantially in a predetermined plane during the operation of the antenna and to provide for the collapse of the reflector when the antenna is not in use.

2. A collapsible antenna, including, an energy radiator, a support member, slots in the support member, a plurality of pliable wires having one end anchored in the slots for a finite and particular wire length and a free end extending outwardly at an adjustable angle relative to the anchored end and in flexible relationship to the anchored end, a reflector made from an interwoven combination of conductive and non-conductive threads to form a ground plane having a negligible impedance, and means for securing the free ends of the wires at spaced intervals to the periphery of the reflector to maintain the reflector in substantially a fixed plane relative to the radiator during the operation of the antenna and to provide for the maintenance of the reflector in a plane substantially parallel to the anchored end until utilization of the antenna.

3. A collapsible antenna, including, an energy radiator, a support member, slots in the support member, a plurality of springs having first and second portions flexible relative

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to each other, the first portions of the springs being anchored in the slots for a finite spring length and the second portions of the springs extending outwardly at a predetermined angle relative to the first portions, a reflector formed from interlaced threads of conductive material to provide a ground plane having a negligible impedance, means connecting the reflector to the support member, means connecting the springs to the reflector at spaced intervals around the periphery of the reflector, and means for holding the springs in a flexed position to minimize the peripheral dimensions of the reflector until the antenna is actually utilized.

4. A collapsible antenna, including, an energy radiator, a reflector formed from threads of a conductive material, an insulator on the radiator for providing an electrical separation between the reflector and the radiator, a plurality of pliable ribs each having first and second portions of finite length, the first and second portions of each rib being in flexible relationship to each other, the second portions of the ribs being attached at spaced intervals to the outer end of the reflector to maintain the reflector in a predetermined plane during the operation of the antenna, and support means on the insulator for supporting the ribs to provide for a pivotal movement of the ribs and the reflector into a folded relationship when the antenna is not in use.

5. A collapsible antenna, including, an energy radiator, a reflector formed from an interwoven combination of conductive and non-conductive threads, an insulator on the radiator for providing an electrical separation between the reflector and the radiator, a sleeve on the insulator, there being a plurality of spaced slots in the sleeve, and a plurality of pliable ribs having first portions of finite length supported by the sleeve within the slots and having second positions secured at spaced intervals to the reflector in flexible relationship to the first portions to maintain the reflector in a predetermined plane during the operation of the antenna and to provide for the collapse of the reflector during the times that the antenna is not being used.

6. A collapsible antenna, including, a radiator, an insulator supported on the radiator, support means fitting on the insulator, there being a plurality of slots at spaced intervals on the inner periphery of the support means, a plurality of pliable ribs each having a first portion of finite length extending through a different slot in the sup-

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port means and a second portion pivotable relative to the first portion of finite length and extending at substantially a right angle to the first portion, and a reflector formed from an interwoven combination of conductive and non-conductive threads and supported by the second portion of each rib in spaced relationship to the radiator so as to have a plane configuration during the operation of the antenna and to follow the movements of the second rib portions into a folded configuration at other times.

7. A collapsible antenna, including, a cylindrical radiator, an insulator supported on the radiator to provide an exposed portion of predetermined length on the radiator, a cylindrical support member fitting on the insulator, there being a plurality of slots extending at spaced intervals along the inner periphery of the support member and in a direction having an axial component a shoulder on the member adjacent the exposed portion of the radiator, a plurality of pliable ribs each having a first portion of finite and particular length extending through a different slot in the support member for support by the member and a second portion of finite and particular length pivotable relative to the first portion and extending at substantially a right angle to the first portion, a collar fitting on the shoulder of the support member, and a reflector formed from an interwoven combination of conductive and non-conductive threads and supported at its inner end between the shoulder and the collar in spaced relationship to the radiator and at its outer end by the second portions of the ribs so as to have a plane configuration during the operation of the antenna and to follow the movements of the second rib portions into a folded configuration at other times.

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