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ELECTRICAL APPARATUS

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FIG. 1A

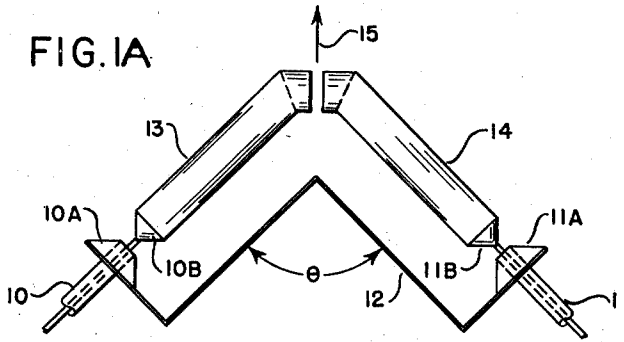


FIG. 1B

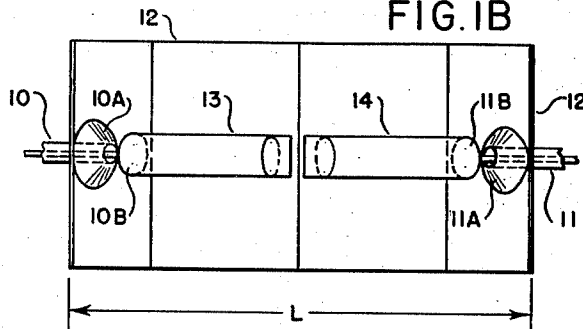


FIG. 2

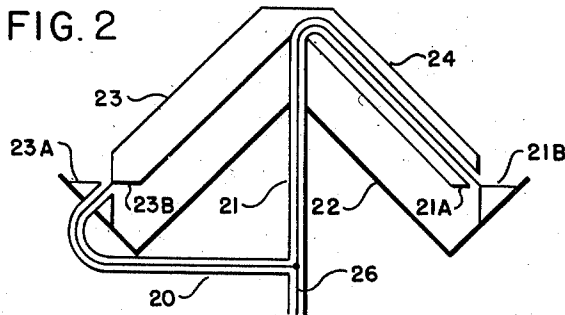
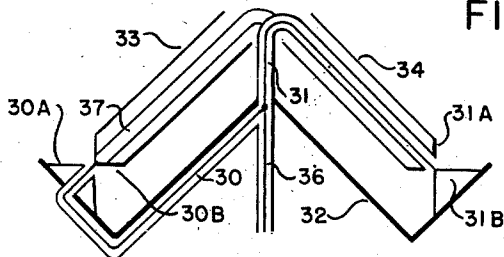


FIG. 3



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This invention relates generally to electrical apparatus and more particularly to antennas.

Often it is desirable to use a unidirectional antenna, particularly in direction finding systems. Directional antennas are certainly not an unusual type, however when additional performance requirements of such an antenna are specified, a compromise on each individual requirement is usually made with the idea of obtaining a resultant antenna which has several characteristics, each of a satisfactory value rather than of optimum value. For example a particular antenna may be required to have a unidirectional pattern and also to be a broad band antenna.

It is an object of the present invention to provide an antenna particularly adapted for use in a direction finding system.

It is also an object to provide a unidirectional antenna for operation over a wide range of frequencies.

It is another object to provide a broad band antenna-reflector combination having a unidirectional pattern.

It is a further object to provide an antenna adapted to be fed by an unbalanced line, such as a coaxial cable without the use of a so-called "balun" which is usually required for connecting a system which is balanced with respect to ground to a system which is unbalanced with respect to ground.

An example of an antenna which accomplishes the above objects consists of an end-connected, V-antenna and a W-reflector. The longitudinal axes of the radiating elements are not common but intersect to form a V, and the sheet reflector is substantially in the form of a W. Such an assembly has a maximum response in the direction of the apex of the V formed by the radiating elements.

Further objects, features and advantages of this invention will suggest themselves to those skilled in the art and will become apparent from the following description of the invention taken in connection with the accompanying drawing in which:

Fig. 1A is a top view of an antenna-reflector assembly embodying the principles of this invention;

Fig. 1B is a side view of the assembly shown in Fig. 1A; and,

Figs. 2 and 3 are schematic diagrams of alternate antenna-reflector assemblies.

Referring now to Fig. 1A, there is shown a unidirectional, broad band, end-connected, V-antenna and a W-reflector assembly. This as-

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sembly is shown fed by a balanced transmission line system consisting of coaxial transmission lines 10 and 11. The ends of the outer conductors of coaxial transmission lines 10 and 11 are flared and terminate in contact with sheet reflector 12, as shown at 10A and 11A. The inner conductors of coaxial transmission lines 10 and 11 are flared as shown at 10B and 11B and terminate in contact with the ends of the antenna radiating elements 13 and 14 respectively. Radiating elements 13 and 14 are substantially cylindrical and their longitudinal axes intersect to form a V at an angle whose value is identical with the angle θ formed by the inner legs of sheet reflector 12. The ends of radiating elements 13 and 14 which form the apex of a V do not make contact with each other but are separated a small distance. In practice, the apex may be either closed, or open as shown in the drawing. The latter condition is slightly better when wide band operation is desired. Arrow 15 indicates the direction of maximum response of the antenna-reflector assembly.

Figs. 1A and 1B are two views of the same apparatus, hence the reference numbers of Fig. 1A are repeated in Fig. 1B.

A modification of the antenna system of Fig. 1A is shown in Fig. 2 wherein the two radiating elements 23 and 24 are made integral where they intersect to form the apex of a V. Although two feed lines 20 and 21 are shown, this arrangement is adapted to be energized by an unbalanced line such as 26, since lines 20 and 21 are connected in parallel. One end of line 20 has its outer conductor terminated by flaring it as shown at 23A and connected to reflector 22. Similarly the inner conductor is flared as shown at 23B and connected to radiating element 23. A portion of line 21 is contained by the full length of radiating element 24 and at an end of element 24, the outer conductor of line 21 is flared as shown at 21A and is connected to element 24. Where the inner conductor of line 21 leaves the confinement of element 24, it is flared as shown at 21B and terminates in contact with sheet reflector 22. To provide proper phasing of the currents in radiating elements 23 and 24, the length of each feed line 20 and 21 from the feed points at the ends of elements 23 and 24 to the junction point of lines 20, 21 and 26, should be the same.

A second modification of the apparatus of Fig. 1A is shown in Fig. 3. Here again, the major parts of the assembly consists of two cylindrical radiating elements 33 and 34, and a sheet reflector 32. Enclosed concentrically in radiating ele-

ment 34 is a portion of coaxial line 31, whose outer conductor is flared as shown at 31A and terminates in contact with an end of radiating element 34. The inner conductor of line 31 extends out of radiating element 34 and is flared as shown at 31B and connected to sheet reflector 32. The other end of line 31 is connected to the main feed line 36 which is also a coaxial line.

Where line 31 connects to line 36, a third coaxial line 30 is also connected to line 36. The inner conductor of this line 30 is flared as shown at 30B and connected to one end of radiating element 33 and near this end, the outer conductor of line 30 is terminated by flaring it as shown at 30A and then grounding it to sheet reflector 32. Concentrically enclosed by radiating element 33 is an impedance balancing conductor 37 which is connected to the end of the inside of element 33 adjacent to point 30B. The other end of conductor 37 is connected to the outer conductor of line 31.

In antenna assemblies of the type disclosed in this invention, the angle θ (Fig. 1) formed by the inner legs of the W-reflector and the angle formed by the radiating elements is not critical but should be of the order of 100 degrees.

As in all antenna systems, the problem of impedance matching is encountered, consequently the ends of the inner and outer conductors of the coaxial feed lines are tapered at points where impedance transformation is required.

To obtain a unidirectional, broad band antenna of the type shown in the drawings, several well known principles have been utilized. A broad band characteristic has been obtained by the use of thick radiating elements. Directional characteristics have been obtained by orienting the radiating elements with respect to each other to form a V, and the value of the angle thus formed is chosen such that the two patterns of the two radiating elements reinforce each other along a line bisecting the V and tend to cancel each other in all other directions. A V-antenna can be made generally unidirectional, however a sheet reflector bent in the form of a W has been used in this invention to further increase the front to back ratio and to increase the gain of the antenna.

Generally, V-antennas have a length which is long compared to a wavelength, however such is not a requirement in the antenna systems herein disclosed. This reduction in required physical length is due to the fact that radiation from a thick element is greater per unit length than from a thin element. Thus, two advantages are gained by using radiating elements of large diameters; the effective Q is lowered permitting broad band operation and the required physical length is reduced.

The frequency range over which the pattern of the antenna shown in Fig. 1 is satisfactory for use in direction finding systems, corresponds to frequencies for which the length L shown in Fig. 1B is between approximately two-tenths wavelength and three wavelengths. Over a somewhat narrower frequency range, modifications of the antenna of Fig. 1 as shown in Figs. 2 and 3 are also satisfactory for use with direction finding systems.

Obviously the antenna shown in Figs. 1A and 1B is designed to be fed by a two wire line which is balanced with respect to ground. The antenna shown in Figs. 2 and 3 are shown connected directly to an unbalanced line without the use of a balun previously referred to in the object of this invention. Such a connection is

possible due to the particular design of these two antennas which eliminates the necessity of a balun.

While there has been described what is at present considered to be the preferred embodiment of this invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the scope of the invention.

10 What is claimed is:

1. A broad band unidirectional end fed dipole V-antenna including a sheet reflector bent in the form of a W, a thick tubular first radiating element oriented parallel to a first inner leg of said reflector, a first coaxial transmission line inserted through a hole in a first outer leg of said reflector with its outer conductor flared and bent backward terminating in contact with said reflector and its inner conductor flared and terminating in contact with an end of said first radiating element, a tubular second radiating element having a large diameter compared to its length oriented parallel to a second inner leg of said reflector, a second coaxial transmission line inserted through a hole in a second outer leg of said reflector with its outer conductor flared and bent backward terminating in contact with said reflector and its inner conductor flared and terminating in contact with an end of said second radiating element whereby the direction of maximum response of said antenna is in a direction of the apex of a V formed by the intersection of the longitudinal axes of said radiating elements.

2. A broad band unidirectional end fed V-antenna including a sheet reflector bent to form four legs in the shape of a W having two outer legs and two inner legs, a thick tubular radiating element bent to form two legs in the shape of a V oriented with respect to said reflector so that the inner legs of said reflector are parallel to corresponding legs of said radiating element, a first coaxial transmission line inserted through a hole in a first outer leg of said reflector with its outer conductor flared and bent backward terminating in contact with said reflector and its inner conductor flared and terminating in contact with an end of a first half of said radiating element, a second coaxial transmission line a portion of which is contained concentrically within a second half of said radiating element with its outer conductor flared and bent backward terminating in contact with an end of said second half of said radiating element and its inner conductor flared terminating in contact with a second outer leg of said reflector, a third coaxial transmission line connected in parallel with an end of each of said first and said second coaxial transmission lines whereby the direction of maximum response of said antenna is in the direction of the apex formed by said radiating element.

3. A broad band unidirectional end fed dipole V-antenna including a sheet reflector bent to form four legs in the shape of a W having two outer legs and two inner legs, a first thick radiating element oriented parallel to a first inner leg of said reflector, a first coaxial transmission line with its outer conductor terminating in contact with said reflector and its inner conductor flared and terminating in contact with an end of said first radiating element, a second radiating element with a large diameter compared to its length oriented parallel to a second inner leg of said reflector, a second coaxial transmission line a portion of which is contained concentrically

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cally within said second radiating element with its outer conductor flared and bent backward terminating in contact with an end of said second radiating element and its inner conductor flared and terminating in contact with a second outer leg of said reflector, a third coaxial transmission line connected in parallel with an end of each of said first and said second coaxial transmission lines whereby the direction of maximum response of said antenna is in the direction of the apex formed by the intersection of the axes of said radiating elements.

4. A broad band end-connected V-antenna including two thick tubular radiators whose longitudinal axes intersect to form a V, a reflector bent to form four legs in the shape of a W having two outer legs and two inner legs oriented behind said radiators on the side of the included angle of the radiators with said inner legs of said reflector parallel to said radiators, and a coaxial transmission line divided into two parallel electrical branches, one of said branches being connected to one of said radiators and the other of said branches being connected to the other of said radiators.

5. A broad band antenna including an end-connected V-antenna, a reflector bent to form four legs in the form of a W having two outer legs and two inner legs located near the side of the included angle of said V-antenna with said inner legs substantially parallel to said V-antenna and a feed line comprising a coaxial transmission line which divides into two parallel branches with the inner conductor of one of said branches connected to one end of said antenna and with the outer conductor of the other of said branches connected to the other end of said V-antenna.

6. A broad band unidirectional end fed V-antenna including a sheet reflector bent to form four legs in the form of a W having two outer legs and two inner legs, a thick tubular radiating element bent to form two legs in the shape of a V spaced from and oriented with respect to said reflector so that the inner legs of said reflector are parallel to corresponding legs of said radiating element, a first transmission line having one conductor thereof terminating in contact with a first end of said radiating element and having a second conductor thereof terminating in contact with said reflector at a point adjacent said first end of said radiating element, and a second transmission line having one conductor thereof terminating in contact with a second end of said radiating element and having a second conductor thereof terminating in contact with said reflector at a point adjacent said second end of said radiating element.

7. A broad band unidirectional end fed V-antenna including a sheet reflector having two outer legs and two inner legs bent in the form of a W, a thick tubular radiating element bent to form two legs in the shape of a V spaced from and oriented with respect to said reflector so that the inner legs of said reflector are parallel to corresponding legs of said radiating element, a first transmission line having one conductor thereof terminating in contact with a first end of said radiating element and having a second conductor thereof terminating in contact with a first outer arm of said reflector at a point adjacent said first end of said radiating element, a second transmission line having one conductor thereof terminating in contact with a second end of said radiating element and having a second

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conductor thereof terminating in contact with a second outer arm of said reflector at a point adjacent said second end of said radiating element, and means for supplying energy to said two transmission lines from a common source at selected distances from their termination with said reflector and said radiating element whereby said first and second ends of said radiating elements are instantaneously of opposite polarity thereby causing the maximum response of said antenna to be along the direction of the apex of the V formed by said radiating element.

8. A broad band unidirectional end fed V-antenna including a sheet reflector bent to form four legs in the form of a W having two outer legs and two inner legs, a thick tubular radiating element bent in the shape of a V oriented with respect to said reflector so that the inner legs of said reflector are parallel to corresponding legs of said radiating element, a first coaxial transmission line inserted through a hole in a first outer leg of said reflector with its outer conductor terminating in contact with said reflector and its inner conductor terminating in contact with an end of a first half of said radiating element, a second coaxial transmission line, a portion of which is contained within a second half of said radiating element with its outer conductor terminating in contact with an end of said second half of said radiating element and its inner conductor terminating in contact with a second outer leg of said reflector and means for connecting said two transmission lines in parallel to a common source whereby the direction of maximum response of said antenna is in the direction of the apex formed by said radiating element.

9. A broad band unidirectional end fed V-antenna including a sheet reflector bent to form four legs in the form of a W having two outer legs and two inner legs, a thick tubular radiating element bent to form two legs in the shape of a V spaced from and oriented with respect to said reflector so that the inner legs of said reflector are parallel to corresponding legs of said radiating element, a first coaxial transmission line inserted through a hole in a first outer leg of said reflector with its outer conductor flared and bent backward terminating in contact with said reflector and its inner conductor flared and terminating in contact with a first end of said radiating element, and a second coaxial transmission line inserted through a hole in a second outer leg of said reflector with its outer conductor flared and bent backwards terminating in contact with said reflector and its inner conductor flared and terminating in contact with a second end of said radiating element whereby the direction of maximum response of said antenna is in a direction of the apex of the V formed by said radiating element.

10. A broad band unidirectional end fed dipole V-antenna including a sheet reflector bent to form four legs in the form of a W having two outer legs and two inner legs, a first tubular radiating element oriented parallel to a first inner leg of said reflector, the inner end of said first element being open, a first coaxial transmission line with its outer conductor terminating in contact with a first outer leg of said reflector and its inner conductor flared and terminating in contact with the outer end of said first radiating element, said inner conductor closing the outer end of said first element, a second tubular radiating element oriented parallel to a second inner leg of said reflector, the inner end of said second element

being open, a second coaxial transmission line, a portion of which passes through the inner open end of said second element and is contained concentrically within said second radiating element, the outer conductor of said second line being flared and bent backward terminating in contact with the outer end of said second radiating element and the inner conductor of said second line being flared and terminating in contact with a second outer leg of said reflector, a tubular conductor having an outer diameter substantially equal to the outer diameter of said second coaxial line a portion of which is contained concentrically within said first radiating element, said tubular conductor having a first end connected to the closed end of said first radiating element and a second end connected to the outer conductor of said second transmission line adjacent the point of its entry into said second radiating element, and a third coaxial transmission line connected in parallel with an end of each of said first and said second coaxial transmission lines whereby the direction of maximum response of said antenna is in the direction of the apex formed by

the intersection of the axes of said radiating elements.

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