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SINGLE NULL LOOP ANTENNA

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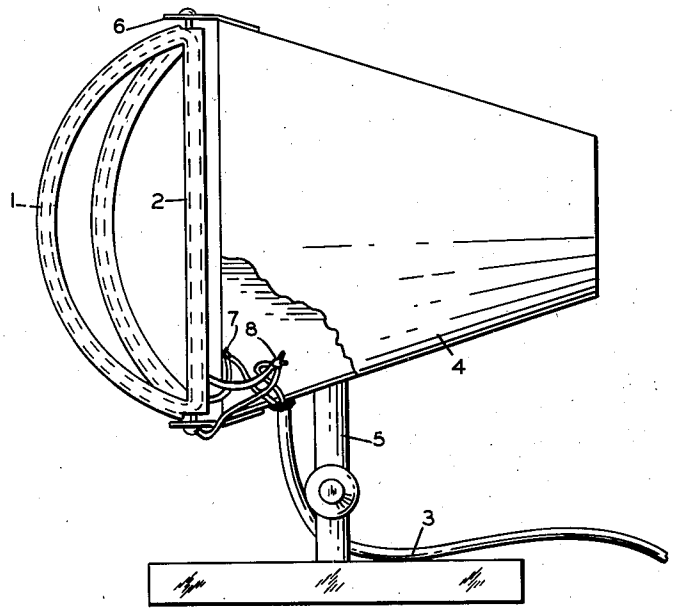


FIG. 1

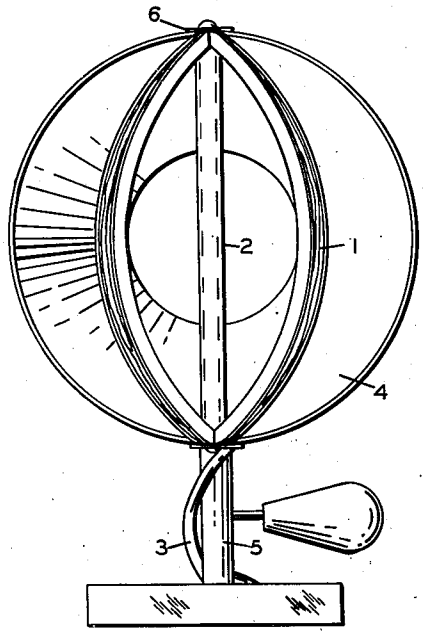


FIG. 2

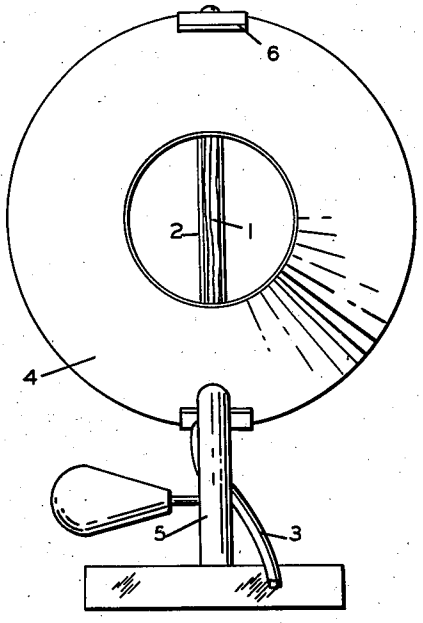


FIG. 3

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SINGLE NULL LOOP ANTENNA

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6 Claims. (Cl. 250—33.67)

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The invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment to us of any royalty thereon.

The invention to be hereinafter described relates to a single null antenna with attenuating wave guide.

Loop antennas, both single and multiple loop and attenuating wave guides have long been in use. The loop antennas as heretofore used are known to have directional characteristics of one or more null points. A well known type of antenna, either single or multiple loop, combines with the loop a powdered iron core. That antenna has a single null but its efficiency at higher radio frequencies is relatively low due to the use of such iron core. All other loop antennas known to applicant have two or more null points.

The main objects of the present invention are to provide a simple, efficient and compact loop antenna of single or multiple loop and having one null point, only, with attenuating wave guide, which will either completely eliminate or greatly minimize the above and other objections.

Well known types of single or multiple loop antennas have multiple null points with respect to a given radiating source such as an antenna. Due to this characteristic two or more directions may be obtained or indicated by them with respect to the particular source of radiation.

The present invention eliminates all but one null point with respect to any such source of radiation. Accordingly, it may be used to definitely establish a single null point and that single null point may be used for establishment of a single direction which would be the direction from which radiations emanate from the radiating antenna or other source. This is true whether the direction be in a horizontal or in a vertical plane or in a plane at any angle between the two.

Another particular of this invention is that when two radiators (two radio stations for instance) are operating on the same frequency, one of them may be received, the null of the present invention being pointed in the direction of the other, thereby eliminating it and resulting in reception from but one. It frequently happens in the use of radios that there are two interfering stations operating on the same frequency either of which may be easily nulled out by this invention, as above. This invention may be readily built into various commercial radio sets, a knob or button being suitably connected to rotate the unit to the desired nulling position.

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Likewise, this unit may be mounted in a plane, boat or any other transport means or it may be mounted at a fixed station. It is, of course, always coupled in well known manner to a receiver. When so connected, rotation, in any suitable manner, may be used to determine the direction of a radiating source.

A very simple construction and arrangement of the invention has been selected for the drawings, comprising two coils disposed approximately at right angles to each other with proper insulation between their adjacent portions. They are shown as approximate semi-circles of the same diameter, in outline, with their respective diameters adjoining and the two loops separated by the above angle, the two loops and diameters defining, substantially a quarter or quadrant of the respective sphere.

In order to more clearly disclose the construction, operation and use of the invention, reference should be had to the accompanying drawings forming part of the present application.

Throughout the several figures of the drawings, like reference characters designate the same parts in the different views.

In the drawings:

Fig. 1 is a side elevation of a preferred construction of the invention;

Fig. 2 is a left hand side elevation of Fig. 1; and

Fig. 3 is a right hand side elevation of Fig. 1.

For simplicity, two loops 1 approximately in the form of semi-circles are provided. In assembling, in accordance with the showing of this application, the two semi-circular coils are disposed at an angle, approximately, of 90° separation therebetween, the axis of rotation being substantially the closely disposed parallel diameters of the two loops. As will be well understood, the loops or coils are insulated from each other throughout, except for terminal connections, in well known manner. This insulation along the parallel adjacent diameters may, very practically, comprise a bar, band, rod, plate or the like 2 of suitable insulating material. A preferred arrangement is to provide such a bar or rod and secure thereto the respective diametrical portions of the loops, the mounting of the loops on the bar being such that the loops will be separated by the desired angle, as, for instance, 90°. And, of course, the disposition of the loops, when mounted, should embrace between them a segment of a sphere corresponding to the angle of separation of the loops 1. It hardly need be stated that the loops may be and, preferably, are parts or portions of one continuous insulated

wire. The wire is simply coiled or wound to produce one loop and then led off at the desired angle and again coiled to form the other loop and, of course, where more than two loops are involved the same procedure as follows, i. e., at the completion of the coiling or winding of each respective loop the wire is led off at the predetermined angle and winding of another loop is similarly made. As each loop is completed its windings are bound together in well known manner as by tape, thread, etc., and the completed loop, along its respective diameter, is anchored, in any one of a number of known ways, to the bar 2. It will be obvious that the preferred construction would involve a permanent position for the respective coils. This is readily obtainable by providing a fixed form of any well known insulating material such as Plexiglass, polystyrene, etc., and binding the coils thereto by the same tape or the like by which the coil spirals are bound together. Or, any other suitable means may be used for securing the coils to the forms.

Although, a circular loop has been repeatedly referred to in this application, it is to be well understood that other shapes of loops may be used. Whatever shape of loop is used it is secured, in the manner stated, to bar 2, preferably, in a fixed angular position relatively thereto and in a fixed angular position relatively to any other coil of the group. The two ends 7 and 8 of the wire are then electrically connected to the wires of the cable 3 leading to usual receiver. Although the coils and loops have been referred to as of one continuous wire it will be readily understood that the coils or loops may be made from separate wires and these separate wires electrically connected.

The bar 2, in the preferred construction, is mounted in and carried by ears or the like extending from one end of a tubular wave guide attenuator 4. This attenuator may be either cylindrical or conical. The construction shown is conical. Where the conical construction is used, the bar 2, with its loops 1, is disposed approximately in the plane of the large diameter of the attenuator or in a plane parallel thereto and closely adjacent. Also, the rod is disposed as a diameter of such large end of the attenuator.

Preferably, though not necessarily the rod 2 is fixed in its mounting so that it does not move relatively to the attenuator but does move with it. It has been definitely established that the most efficient mounting or arrangement of the parts, when two such coils are used at 90° separation, is with the supporting rod 2 secured diametrically across the large open end of the attenuator and each loop 1 forming an angle of 45° with the adjacent attenuator end wall, portion or edge. In that position the coils are symmetrically disposed. Although a conical attenuator has been illustrated and has proven highly satisfactory a cylindrical attenuator is very practical. While attenuators of a considerable range of proportions will work with loops of the same dimensions it has been found that there are certain approximate relative proportions which give more satisfactory results than others. For instance, the length of the attenuator should not be less than its greatest diameter. For highest attenuating efficiency the length should not exceed three times the greatest diameter. For best practical purposes, including good attenuating efficiency, the length should be one and two tenths (1.2) times

the greatest diameter. When the length is increased to more than three times the diameter there will be attenuation but not as great or as efficient.

The diameter of the loop should be such that the windings bridging the arc and corresponding to its diameter are only slightly less in length than the greatest inside diameter of the attenuator. This will enable these windings, in assembled relation, to extend along and be connected to rod 2 and to be readily mounted therewith and thereon between the diametrically disposed ears 6 extending from the attenuator. Thus, where semi-circular loops are used they may, practically, be of substantially the same diameter as the greatest diameter of the attenuator.

With the loops 1 and attenuator 4 assembled as above indicated, the two constituting a unit, such unit may be readily manipulated by any suitable handle, grip or the like. One such arrangement would be a stem, staff or post 5 connected to the attenuator and which, conveniently, could extend substantially parallel with rod 2. Any suitable base may be provided on 5 for maintaining the post and unit in upright position. Also, any suitable handle may be connected to the post for turning the unit through any desired angle in either a horizontal or a vertical plane. It is hardly necessary to state that the loop assembly may be operated in various other ways than merely manually. For instance, any power means either directly or remotely controlled and suitably connected may be used.

The attenuator and loops, as a unit, assembled and arranged as hereinabove set forth, provide a radio frequency loop antenna with a single null. This, in turn, makes it possible to use the unit, selectively, to null out any one particular station or source of radio frequency interference.

In using the invention, with the parts assembled as hereinabove set forth, it is only necessary to rotate the assembly about post 5 until the intersection of the loops and, therefore, the opposite end of the attenuator are aligned with a particular station. For instance, if there are two interfering stations, by so rotating or moving the unit, the single null of the invention may be directed against the interfering station completing blanking out or shutting off the interference. In that position, the counter currents passing through the attenuator, apparently, cancel each other, while the frequencies passing around the attenuator and in that way reaching the loops come from stations which are not aligned with the single null point of the unit. Between that point and a point 180° rotated therefrom, there will be corresponding gradations of reception and shutting out of reception.

It is thought that the construction, operation and use of the invention will be clear from the preceding detailed description.

The theory of operation is believed to be as follows:

Considering only the two crossed loops without the wave guide, these loops provide a figure of eight pattern. Since the two loops are series wound, the adjacent portions of the loops are in phase with each other, the remote portions of the loops are similarly in phase with each other, and therefore the two radiation patterns reinforce each other along a line bisecting the right angle inclosed by the loops. It therefore results that the loops by themselves provide substantially a figure of eight pattern that lies along an axis including the longitudinal axis of the wave guide,

and that a null axis is perpendicular to the chord and lies in a plane parallel to the mouth of the wave guide.

Considering now the wave guide without the crossed loops, it is dimensioned to be beyond the cut off point for all sources of transmitted energy remote from the wave guide. Thus energy from an unwanted source, wherein the source lies on the longitudinal axis of the wave guide and on the small end side of the wave guide, will be completely attenuated by the wave guide and no energy will pass through the wave guide. It therefore may be considered that the wave guide presents a null point to the source of unwanted energy. Regardless of any other effect that the wave guide may have relative to sources of energy not on the axis, reception by the wave guide, or the radiation pattern laid down by the wave guide, is zero along this axis on the small end side.

It will thus be seen that there exists a figure of eight pattern having two lobes displaced by 180° and that a wave guide attenuator lies along the lobar axis of said loops. Transmitter remotely positioned along said axis and on the small end side of the wave guide will be completely blanked out due to the cut-off property of the wave guide. It will thus be seen that for this transmitter the two loop wave guide combination provides a null, even though the loops by themselves would provide a lobe. Thus it will be seen that regardless of the radiation pattern of the loops, the wave guide cooperates therewith to provide a null which may be pointed toward the source of an unwanted signal.

We thus have a system wherein a source of energy lying on the wave guide side of the lobe axis will be blanked out and wherein sources of energy lying on the crossed loop side of the lobe axis will be received on the forwardly extending resultant one-half figure of eight pattern. The question now arises as to whether or not signals from sources angularly disposed with respect to the axis will be received. Or, to rephase the question, whether only those signals will be received which will fall within the resultant one-half figure of eight pattern.

It is believed that the explanation of reception lies in the fact that the outer surface of the wave guide becomes energized, reradiates and produces a distorted field that is picked up by the loops carried by said wave guide. Thus, consider a source of energy angularly displaced from the source of signal that is blanked out, said source being apparently shielded from the crossed loops by the wave guide. Energy incident on the outer surface of said wave guide will cause said outer surface to become a radiator, said effect being similar to that produced by one-half of a biconical horn. The radiation pattern set up by said outer surface of the wave guide is undoubtedly a distorted one, and undoubtedly spills over at the large end to excite the crossed loops. That the energy spills over at the large end is reasoned from the analogy that a directional reflector, i. e., a parabolic reflector, is frequently supplied with quarter wave traps about the periphery thereof to prevent backward radiation. In this case, the absence of a wave trap permits forward radiation and results in excitation of the crossed loops.

The resultant radiation pattern set up by this crossed loop wave guide combination approaches a cardioid pattern having a single, very sharp null point. The forward part of this pattern is

provided by the uncancelled one-half figure of eight pattern and the remaining portions of the pattern are supplied by the forwardly extending distortion field set up by the wave guide.

Changes may be made in the construction, arrangement and disposition of the various parts of the invention within the scope of the claims without departing from the field of the invention and it is meant to include all such within this application wherein only one preferred form has been illustrated, purely by way of example and with no thought or intent to in any degree limit the invention thereby.

It will be further understood that although this specification has been directed to the reception of energy by the antenna disclosed herein, the antenna may also be used to transmit energy.

Having thus described our invention, what we claim and desire to protect by Letters Patent is:

1. In combination, a tapered wave guide attenuator, a loop antenna mounted in the larger end thereof with a chord of the loop disposed diametrically of said attenuator and the plane of said loop disposed at an angle to the longitudinal axis of said attenuator.

2. In combination, a tapered wave guide attenuator, a loop antenna mounted in the larger end thereof and comprising a plurality of loops, the planes of said loops being disposed perpendicularly relatively to each other and intersecting at 45° the longitudinal axis of said attenuator, the chords of said loops being disposed approximately coincident with a diameter of said attenuator.

3. In combination, a tapered wave guide attenuator, a loop antenna mounted in the larger end thereof and comprising a plurality of loops, the planes of the loops being disposed perpendicularly relatively to each other and at 45° to the longitudinal axis of said attenuator, the chords of said loops being disposed approximately coincident with a diameter of said attenuator, said attenuator having a length not less than its greatest diameter.

4. A single null antenna comprising a wave guide and a loop antenna positioned at one end thereof, said loop antenna comprising a pair of loop components lying in crossed planes and being receptive to energy lying in a frequency range in which said wave guide presents a high impedance, said loop antenna and said wave guide cooperating to produce a single null radiation pattern.

5. A single null antenna comprising a wave guide and a loop antenna positioned across one end thereof, said loop antenna comprising a pair of loop components lying in crossed planes and being tuned to receive energy lying within a given frequency range, said wave guide being so dimensioned as to be non-receptive to energy lying in said frequency range whereby the radiation pattern of said antenna presents a sharp null when the free end of said wave guide is directed toward the source of energy.

6. The combination, with a wave guide tapered from a large end to a small end, of a pair of series connected loops, said loops lying in planes which intersect along a common diameter in the large end of said wave guide and intersect the longitudinal axis of said wave guide in equal angles.

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(References on following page)

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,847,872	Hand	Mar. 1, 1932
2,062,129	Hefele	Nov. 24, 1936
2,169,742	Scharlau	Aug. 15, 1939
2,283,935	King	May 26, 1942
2,337,324	Grangvist	Dec. 21, 1943
2,337,965	Blodgett	Dec. 28, 1943
2,354,332	Polydoroff	July 25, 1944

FOREIGN PATENTS

Number	Country	Date
731,965	France	Sept. 10, 1932
556,169	Germany	Nov. 9, 1933