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LINEARLY POLARIZED SPIRAL ANTENNA SYSTEM AND FEED SYSTEM THEREFOR

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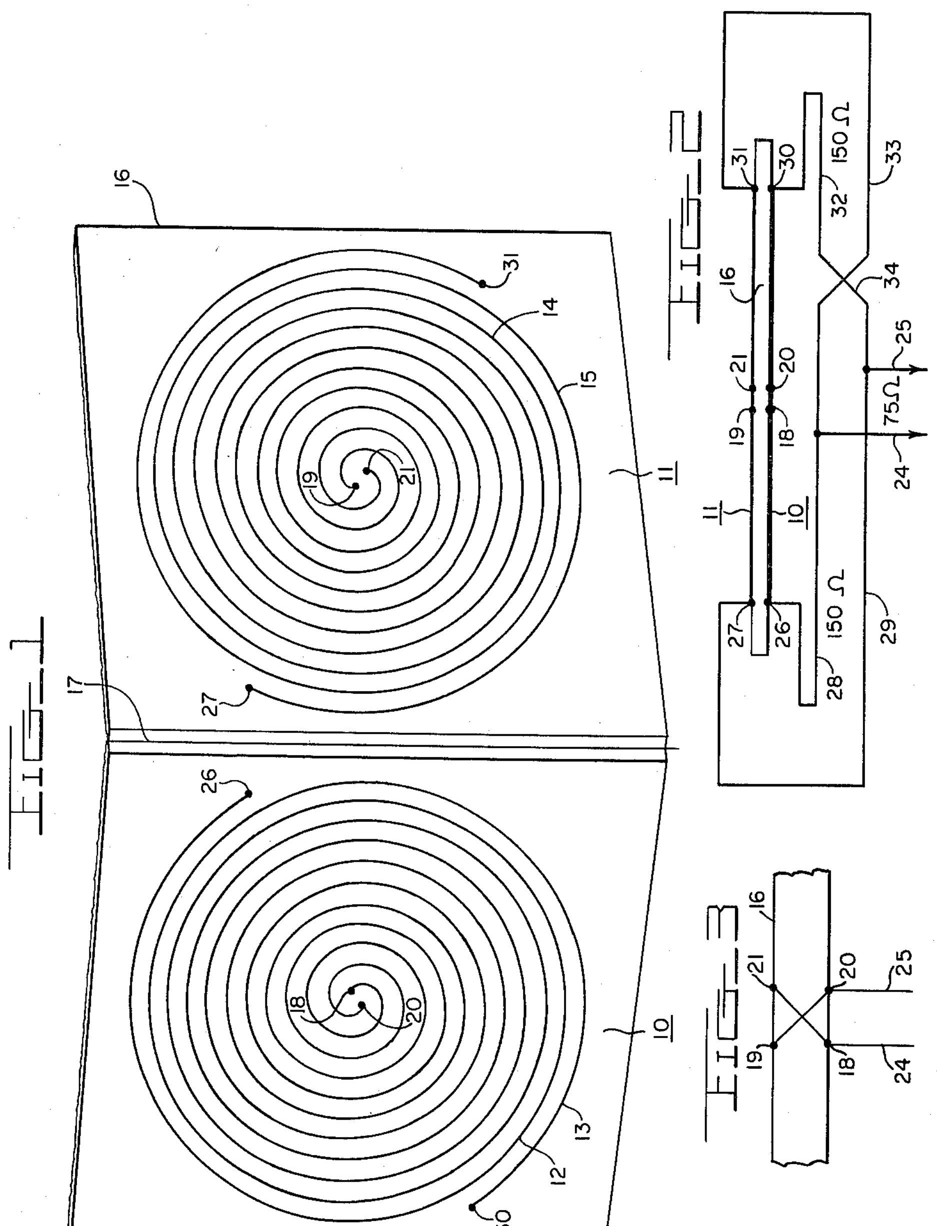

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LINEARLY POLARIZED SPIRAL ANTENNA SYSTEM AND FEED SYSTEM THEREFOR

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The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

This invention relates to spiral antenna systems in general and in particular to spiral antenna systems capable of producing linear polarization and to feed systems therefor.

In its basic form the spiral doublet antenna utilizes two two-conductor archimedian spiral antenna elements of opposite configuration sense mounted side by side in the same plane. With such an antenna it is possible to obtain linear polarization rather than the conventional circular polarization produced by a single spiral antenna element, it also being possible to provide convenient adjustment and control over the plane of polarization as well as of the phase existing in any point in the far field merely by rotation of the elements. Such an antenna requiring as it does two basic antenna elements is less conservative of space and supporting structure than is desired in some instances. Such space requirement, although of no particular concern where only a few elements are involved, does become a substantial consideration where a great number of spiral antenna elements are employed in an array to produce scanning of a narrow, linearly polarized, beam over a sector of space. Such a side by side doublet arrangement also suffers from the further disadvantage that it is occasionally somewhat difficult to maintain the exact required excitation relationship of the two elements of each doublet over a wide frequency range thus restricting the band width over which desired operation is possible. In view of the foregoing, then it has become desirable to obtain some means for reducing the space requirements for the spiral doublet array as well as to provide simplified feed, excitation or coupling as the case may be, between the antenna and the associated transmission or reception equipment to permit more flexible operation under certain conditions.

Accordingly it is an object of the present invention to provide a spiral doublet antenna system whereby linear polarization is obtained, such system being of smaller physical dimensions than the prior art.

Another object of the present invention is to provide an improved feed system for a spiral doublet antenna system.

Another object of the present invention is to provide a spiral doublet antenna system having improved polarization linearity over a wide frequency range.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

FIG. 1 shows, in a somewhat exploded form, a view of an antenna system constructed in accordance with the teachings of the present invention.

FIG. 2 shows an arrangement for feeding the spiral antenna system of FIG. 1 in which uniformity of operation over a wide frequency range is readily obtainable.

FIG. 3 shows schematically an arrangement for feeding the spiral antenna system at the centers of the elements.

In accordance with the basic teachings of the present invention a spiral antenna system is provided wherein two spiral antenna elements of opposite configuration sense are mounted back to back in close proximity to each other and in which the feed to associated equipment is connected to the outer terminus of the conductors of the spiral antenna elements rather than at the centers of the spiral antenna elements, the central conductors of the spiral antenna elements being connected to each other.

With reference now to FIG. 1 of the drawing, the apparatus shown therein contains two spiral antenna elements indicated generally by the numerals **10** and **11** with element **10** having the conductors **12** and **13**, element **11** having conductors **14** and **15**. Each pair of conductors forms an intertwined archimedian spiral outward from a central portion of a small radius to an outer portion of a large radius. The two elements **10** and **11** are mounted upon a suitable base member **16** which has been shown as though it were sliced through the middle and pivoted about one edge **17** in order to illustrate more clearly the arrangement of the components thereof. Actually the complete doublet antenna would be permanently closed like a book about the edge **17**, the result being two spiral antenna elements placed back to back in close proximity separated by the thickness of the member **16**. It is to be noted that the two spiral antenna elements **10** and **11** are of opposite configuration sense, that is one of them spirals outward in a left hand direction while the other spirals outward in a right hand direction, viewing the elements from the front of each.

To simplify the problem of matching and balancing the feed to the spiral antenna elements, a balanced parallel wire feed system has certain advantages, these wires being connected to the outer terminals of the conductors **12**, **13**, **14** and **15**, the connections being indicated in FIG. 2 to which attention is now directed. A 75 ohm transmission line having the conductors **24** and **25** provides the common feed for the antenna system, these conductors being connected to terminals **26** and **27** of conductors **12** and **15**, respectively, via a section of transmission line of 150 ohm impedance having the conductors **28** and **29**, and to terminals **30** and **31** of conductors **13** and **14**, respectively, via a second section of transmission line having a characteristic impedance of 150 ohms and the conductors **32** and **33**. Typically to provide the out of phase excitation of the conductors **27** and **31** as well as the out of phase excitation of the terminals **26** and **30** the connections to one pair of terminals are reversed as indicated by the cross portion **34** in the conductors **32** and **33**.

As shown, the feed arrangement is intended to provide terminals **27** and **31** with out of phase excitation and also terminals **26** and **30** with out of phase excitation, the terminals **27** and **26** being excited out of phase and the terminals **30** and **31** being excited out of phase. Thus terminals **27** and **30** are operated substantially in phase and **26** and **31** are substantially in phase. Although the result will vary with variations in the phasing of the terminals, as long as the out of phase excitation of the terminals **27** and **31** and also that of the terminals **26** and **30** is maintained, there is no particular requirement to obtain a specific relative phasing of the two spirals because any variation at this point would merely change the polarization angle which is of course readily adjusted in any event merely by rotation of the spirals. Thus if there is some unbalance in the transmission line of wires **28** and **29** so that the two signals are not exactly out of phase there is no particular problem introduced as far as the antenna itself is concerned provided this same unbalance is also experienced in the excitation of terminals **30** and **31**. Thus the system is very simple and reliable and possesses considerable flexibility of arrangement and operation.

Like the basic spiral doublet antenna, the back to back spiral doublet is also capable of being fed at the center of the spirals without any particular difficulty involved extending the utility of the overall apparatus to situations wherein the somewhat greater complexity of the feed system of FIG. 2 would not be desired. In such an instance it would be satisfactory to feed the antenna system by means of a single balanced transmission line of suitable impedance characteristics connected to the spiral arrangement in such a way that one conductor of the transmission line is connected to terminals **18** and **19** and the other conductor of the transmission line is connected to terminals **20** and **21** of the spirals as indicated in FIG. 3.

The operation of the apparatus of FIGS. 1 and 2 is basically self evident in view of the prior discussion of the arrangement of apparatus contained therein. Normally the terminals of the spirals will be connected through the transmission line **24—25** to some remote utilization device such as a transmitter or a receiver by means of which the antenna may be employed for the transmission or the reception of radio frequency energy. The arrangement as described provides coupling which is perhaps more easily visualized in the transmission phase of operation as producing a radio frequency field which is linearly polarized in space and in which the direction of polarization is readily variable merely by rotation of the spiral antenna elements **10** and **11**.

In typical operation of the apparatus of the present invention over a frequency range from 1000 to 2000 megacycles per second without necessitating any rearrangement, spiral conductor outside diameters of 4 inches would be typical, the two spiral elements **10** and **11** being produced by printed circuit techniques, the elements **10** and **11** being separated merely by the thickness of the base member **16** which supports the printed circuit conductors disposed on the sides thereof. The overall apparatus permits considerable space and weight savings particularly where a reflector is employed to limit radiation from one side for the spiral arrangement, because the overall assembly is only half the size of the conventional side by side spiral doublet. Thus considerable savings in space and weight of associated apparatus are made possible.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. A spiral antenna system comprising, first and second spiral antenna elements, each having first and second conductors, means for positioning said elements back to back, first and second two conductor transmission lines, means connecting the first transmission line to the first conductors of the elements, means connecting the second transmission line to the second conductors of the elements, a signal operative circuit, and means for connecting said transmission lines to said circuit whereby a desired phase relationship is obtained in the coupling through the first and second transmission lines.

2. A spiral antenna system comprising, a planar base member of insulating material, a first spiral antenna element having two conductors disposed upon one side of the base member, a second spiral antenna element having two conductors disposed upon the opposite side of the base member, the centers of the elements falling on the axis normal to the plane of the base member, and a transmission line connected to the conductors of the elements.

3. A spiral antenna system comprising, a planar base member of insulating material, a first spiral antenna element having two conductors disposed upon one side of the base member, a second spiral antenna element having two conductors disposed upon the opposite side of the base member, the centers of the elements falling on an axis normal to the plane of the base member, and a transmission line connected to the conductors in the region of the center of the elements.

4. A spiral antenna system comprising, a planar base member of insulating material, a first spiral antenna element having two conductors disposed upon one side of the base member, a second spiral antenna element having two conductors disposed upon the opposite side of the base member, the centers of the elements falling on an axis normal to the plane of the base member, and a transmission line feed system connected to the conductors of the elements at the periphery thereof.

5. A spiral antenna system comprising, a planar base member of insulating material, a first spiral antenna element having two conductors disposed upon one side of the base member, a second spiral antenna element having two conductors disposed upon the opposite side of the base member, the centers of the elements falling on an axis normal to the plane of the base member, and a transmission line feed system connected to the conductors of the elements at the periphery thereof whereby the conductors of each element are fed in a push-pull relationship to each other.

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