Nov. 30, 1926. 1,608,974

A. S. BLATTERMAN

APPARATUS FOR CONTROLLING THE DIRECTIONAL RECEPTION CHARACTERISTICS OF LOOP OR COIL ANTENNAE

Filed Jan. 26, 1921 4 Sheets-Sheet 1

Fig 1

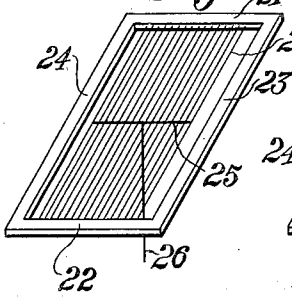



Fig 2

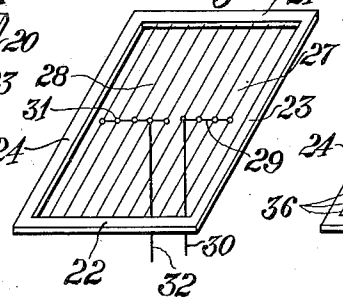



Fig 3

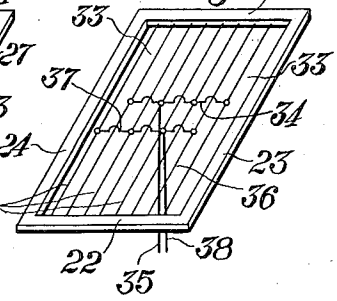



Fig 4

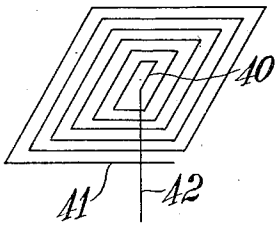



Fig 5

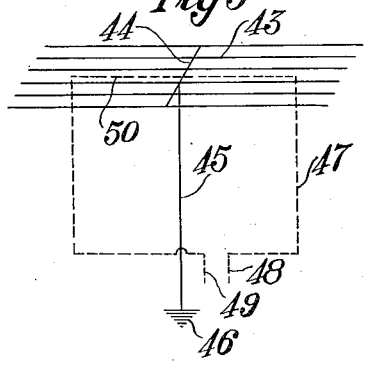



Fig 6

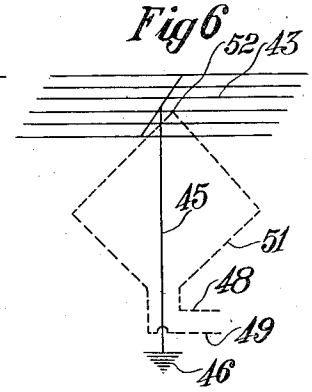
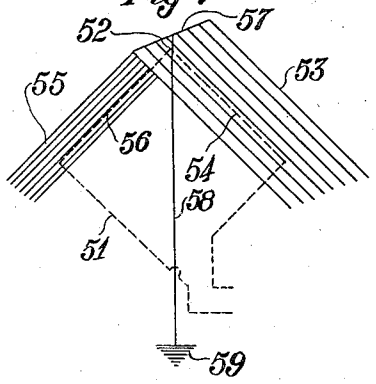



Fig 7




Albert S. Blatterman Inventor

By Roberts & Young Attorneys

Nov. 30, 1926. 1,608,974

A. S. BLATTERMAN

APPARATUS FOR CONTROLLING THE DIRECTIONAL RECEPTION CHARACTERISTICS OF LOOP OR COIL ANTENNAE

Filed Jan. 26, 1921 4 Sheets-Sheet 2

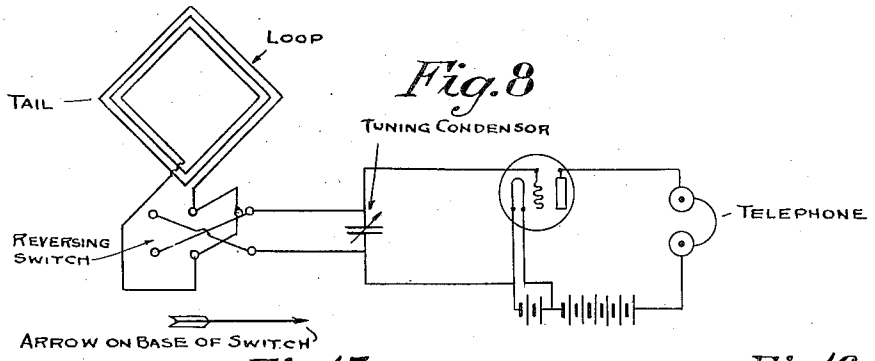



Fig. 8

Fig 15

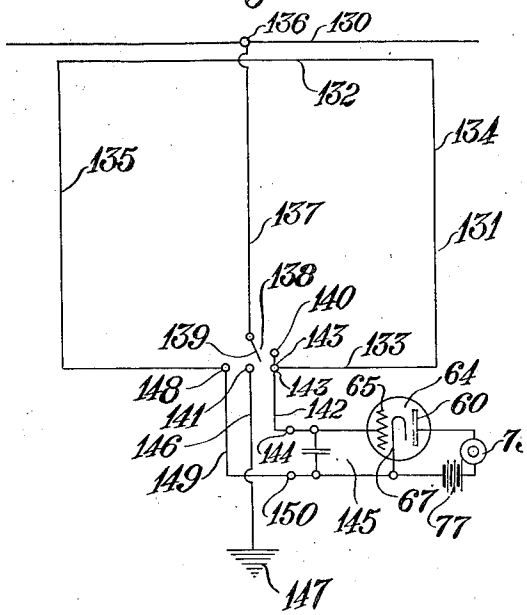
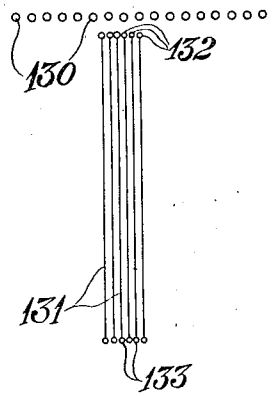



Fig 16




Albert S. Blatterman Inventor

By Robert A. Young Attorney

Nov. 30, 1926. 1,608,974

A. S. BLATTERMAN

APPARATUS FOR CONTROLLING THE DIRECTIONAL RECEPTION CHARACTERISTICS OF LOOP OR COIL ANTENNAE

Filed Jan. 26, 1921. 4 Sheets-Sheet 3

Fig 9

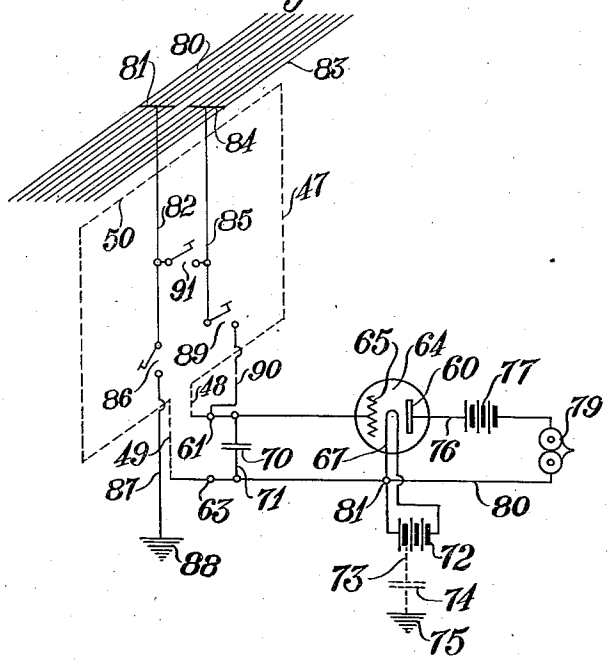



Fig 10

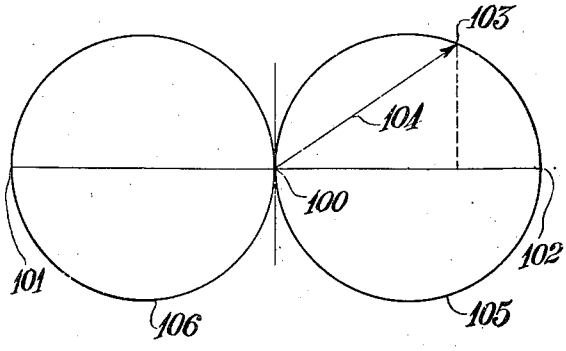
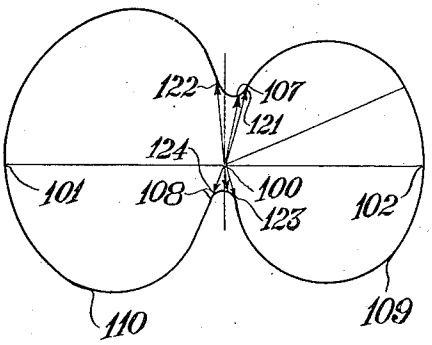



Fig 11




Albert S. Blatterman Inventor

By Robert H. Young Attorney

Nov. 30, 1926. 1,608,974

A. S. BLATTERMAN

APPARATUS FOR CONTROLLING THE DIRECTIONAL RECEPTION CHARACTERISTICS OF LOOP OR COIL ANTENNAE

Filed Jan. 26, 1921 4 Sheets-Sheet 4

Fig 12

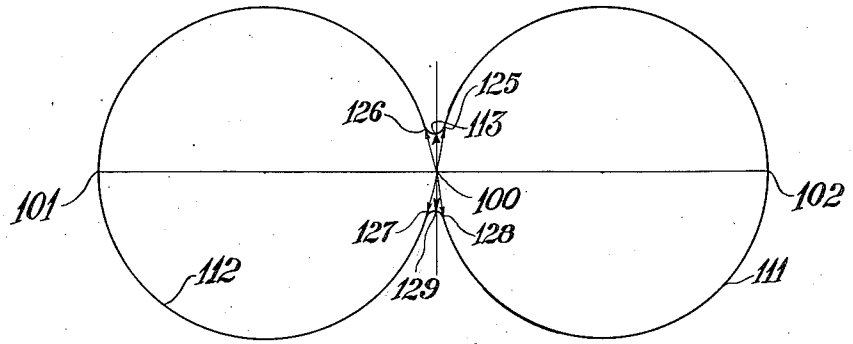



Fig 13

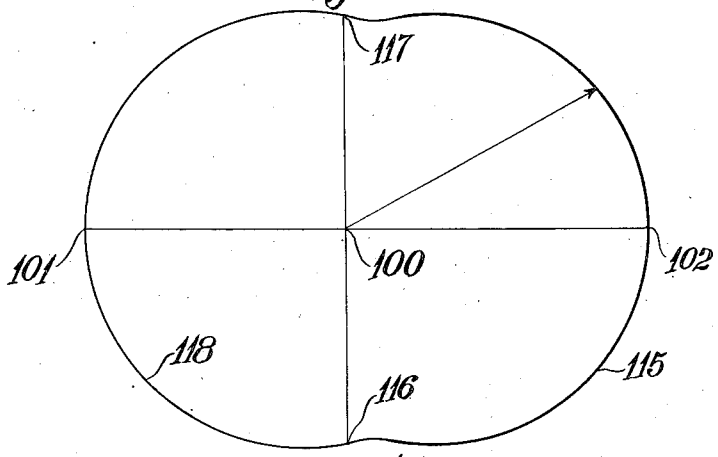
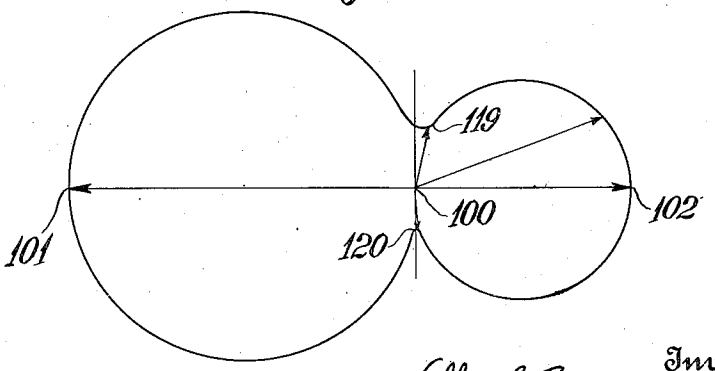



Fig 14




Inventor

Albert S. Blatterman

By Robert Young Attorney

Patented Nov. 30, 1926. 1,608,974

# UNITED STATES PATENT OFFICE.

ALBERT S. BLATTERMAN, OF VAIL, LITTLE SILVER, NEW JERSEY, ASSIGNOR TO MURAD RADIO CORPORATION, A CORPORATION OF DELAWARE.

## APPARATUS FOR CONTROLLING THE DIRECTIONAL RECEPTION CHARACTERISTICS OF LOOPS OR COIL ANTENNÆ.

Application filed January 26, 1921. Serial No. 440,106.

This invention relates to apparatus for controlling the directional reception characteristics of loop or coil antennæ.

An object of this invention is to provide improved means for determining the direction of reception of radio communication. A further object of the invention is to provide improved means for increasing the directional sharpness of reception or for increasing the symmetry of the directional receiving characteristics.

A further object of the invention is to provide improved means for altering the directional receiving characteristics so as to minimize the normal directional property of the receiving loop or coil and permit reception to substantially equal degree from all directions.

A further object of the invention is to provide means for determining the sense or absolute direction of reception.

A feature of the present invention is the use of a metallic structure usually in the form of a harp or grid of parallel wires electrically connected to one another and either grounded or connected to the receiving set. Such metallic structure may be in the form of substantially parallelly arranged wires mounted on an insulating frame and electrically connected to one another through the lead wire connecting such parallel wires to ground or to the receiving set. Other forms of such metallic structure may be employed as pointed out more particularly hereinafter.

With the use of such metallic structure atmospheric disturbances or other disturbing effects due to trees, buildings, metal structures are largely eliminated and the determination of direction of reception is accomplished more readily and more accurately.

The use of such metallic structure also enables the asymmetry of the reception characteristics to be enhanced for the purpose of determining the absolute direction or sense of the distant transmitter.

Further features and objects of the invention will be more fully understood from the following detailed description and the accompanying drawings, in which—

Fig. 1 is a perspective view showing one form of grid of wires serving as a metallic structure and embodying my invention;

Figs. 2, 3 and 4 are similar views of three different modifications of such metallic structure;

Fig. 5 is a diagrammatic view showing a form of my metallic structure employed with a vertically arranged radio receiving loop;

Figs. 6 and 7 are diagrammatic views similar to Fig. 5 showing modifications;

Fig. 8 is a diagrammatic view showing a form of my double-pole, double-throw switch in connection with the receiving set whereby the loop terminals may be connected in reversed relation thereto;

Fig. 9 is a diagrammatic view showing another form of my metallic structure and a modified arrangement of connection with the receiving set;

Figs. 10, 11, 12 and 13 and 14 are diagrams showing the symmetry and asymmetry of directional receiving characteristics;

Figs. 15 and 16 are respectively diagrammatic side and end views showing one form of arrangement of a loop receiving antenna and a vacuum tube receiving set, combined with a form of my metallic structure.

As will appear more fully hereinafter, this invention is directed particularly to the use of an untuned metallic structure electrically related to a loop receiving antenna system for increasing the sharpness of its directional receiving characteristic. Such metallic structure, I have discovered, may take the form which may be described as a harp or as a grid of substantially electrically parallel conducting wires, electrically connected with one another and suitably grounded. In Fig. 1 I have shown such metallic structure as comprising a single set of wires 20 strung at their respective ends from the opposite end members 21, 22, of a substantially rectangular frame, formed of wood or like rigid, electrically non-conducting material. The side members of such non-conducting frame are indicated at 23, 24. These wires 20 are electrically connected to one another by means of the cross wire 25 and the ground wire indicated at 26 is shown in this instance connected directly to the cross wire 25.

In Fig. 2, I have shown two sets of parallelly arranged wires designated respective-

ly 27, 28, and similarly mounted to be strung within the frame formed of the end members 21, 22, and side members 23, 24. The wires of the set 27 are connected to one another by means of the cross wire 29 and grounded through the ground wire 30 and the set of wires 28 are connected to one another by means of the cross wire 31 and grounded through the ground wire 32. These sets of wires 27, 28 are shown disposed as one set 27 at the right in the frame and the other set 28 at the left in the frame. In Fig. 3, I have shown a similar frame 21, 22, 23, 24 of wood or the like, and two sets of wires, the sets of wires being arranged alternately within the frame. The set of wires 33 are connected to one another by the cross wire 34 and grounded through the ground wire 35, whereas the other set of wires 36 is connected together by means of the cross wire 37 and grounded through the ground wire 38.

In Fig. 4 I have shown a further modification of harp or grid of parallel wires in the form of a rectangular spiral, the innermost portion being indicated at 40 and the outermost portion at 41, and suitably grounded through the ground wire 42 as by connection with the innermost turn 40. Such spiral 40, 41 may be supported in a similar manner on a framework of wood or other insulating material, as by two diagonally crossing supporting arms, as will be understood.

In Fig. 5, I have shown diagrammatically a harp or grid of parallel wires 4 arranged in any of the forms set forth in the previous figures and I indicate at 43 a set of such parallelly arranged wires and at 44 a cross connecting wire and at 45 the ground wire shown diagrammatically grounded at 46. The loop receiving antenna is indicated at 47 in dash line and its terminal wires at 48, 49, connected in any approved manner to an approved type of receiving set, employing a vacuum tube or other type of detector.

In Fig. 5 such receiving loop 47 is positioned substantially vertically whereas the set of parallel wires 43 is positioned substantially horizontally. In the discoveries which I have made, the usual clearance between the upper wire portion 50 and the plane of the wires 43 is of the order of from a fraction of an inch to a few inches, dependent upon the particular receiver loop employed, and the desired degree of symmetry or asymmetry.

In Fig. 6 I have shown the use of my invention with a loop receiving antenna 51 disposed substantially vertically, of substantially rectangular formation but arranged to have the angle 52 of such rectangular loop at the uppermost apex and the grid or harp of wires 43 is positioned substantially horizontally and connected by the ground wire 45 to ground at 46. The terminals 48, 49 of the loop 51 are connected to the terminals of the receiving set in the usual manner.

If desired, the grid 43 may be positioned below the apex 52 of the loop 51, in which position the plane of the loop 51 is between the wires 43 of the grid.

In Fig. 7, I have shown a similar type of vertically disposed substantially rectangular form of loop antenna 51 having its apex disposed at 52 and the harp or grid of parallel wires are arranged in two planes without the horizontal, one set of wires 53 being substantially parallel to one another and substantially parallel to the side wires 54 of the rectangular loop 51 and perpendicular to the plane of the four sides of the rectangular loop 51 and the other set of wires 55 substantially parallel to one another and also substantially parallel to the side wires 56 of the loop 51 and perpendicular to the plane of all of the side wires of the loop 51. The two sets of wires 53, 55 are connected to one another by means of the cross wire 57 and grounded through the wire 58 to ground 59. The wires 53, 55 are suitably supported in a wooden or similar non-conducting material of a contour corresponding to the contour of the sets of wires 53, 55 in like manner corresponding to the particular frame shown in Figs. 1, 2 and 3.

In Fig. 9, I have shown a harp or grid comprising two sets of parallelly arranged wires similar to that shown in Fig. 2 aforesaid, one set of wires being indicated in Fig. 9 as 80 and connected to one another by the wire 81, and grounded through the conductor 82 and the other set of wires is indicated at 83 connected together by the cross wire 84 and grounded through the conductor 85. The rectangular receiving loop is indicated at 47 similar as aforesaid and its terminal wires 48, 49 connected to receiver terminals 61, 63.

However, in Fig. 9, the ground wire 82 is provided with the switch 86 for connecting and disconnecting with the conductor 87 leading to ground 88, and the ground wire 85 is provided with the switch 89 for connection and disconnection with the conductor 90 leading to the receiver terminal 61. In this arrangement I have also shown switch 91 for connecting and disconnecting the two ground conductors 82, 85 with one another.

In the use of this embodiment of my invention, for the purpose of listening in for stations, switches 91 and 89 are closed and the switch 86 opened whereby the two sets of wires 80, 83 are connected with the receiving set which is thereby rendered highly sensitive in non-directional reception, that is to say, signals will be heard almost equally well from all directions without the neces-

sity of rotating the loop. After the desired signals have been intercepted, using this connection the switch 91 is then opened, whereby the set of wires 83 solely are connected with the receiver set. Thereupon, the loop 47 is rotated until the strength of reception is increased to maximum, in which position the plane of the loop coincides approximately with the direction of propagation of the wave.

The sense or absolute direction of the distant transmitter is then determined by comparison of the relative strengths of reception with the loop in the last-named position and in the position obtained when rotated 180 degrees in azimuth from same.

In lieu of rotating the loop through 180 degrees azimuth, a double pole, double throw reversing switch may be provided for the loop terminals 48 and 49 on one side of the switch and the receiver terminals 61, 63 on the other side, whereby the loop terminals may be connected in reversed relation to the receiving set. For this arrangement, as shown in Fig. 8, one side of the loop is marked "head" and the other side "tail". Direction of transmitting station is determined by throwing the reversing switch pointing to the tail of the arrow, the transmitter is in the direction of the tail of the loop. If the strongest signal is received with the switch in the position of the head of the arrow, marked on the switch, the station is in the direction of the head of the loop.

Having now determined the sense of the direction of the distant transmitter, the switch 89 is opened and switches 86 and 91 are closed, whereby both sets of wires 83, 80 of the grid are directly grounded through the ground wire 87 and without the receiver set, whereby the directional characteristics of the system are greatly intensified and made more symmetrical, so that the accurate bearing of the distant transmitter may be taken.

I have represented in Fig. 10, the intensity of received energy plotted in polar coordinates for different angular positions of the plane of the loop, the origin being indicated at 100 and the different planes being measured in a counterclockwise direction from the axis 101, 102 as indicated. Thus, for any particular plane represented by the angle 102, 100, 103, the intensity of the received energy from a given station in line with the axis 101, 102, at a given intensity of transmission is represented by the length of the radius vector 104. The right hand lobe shown in the form of a circle 105 having its left hand extremity of diameter at 100, represents substantially perfect symmetry of the reception characteristic for different positions from —90° to +90°, whereas the left hand lobe 106 also a circle, having its right hand extremity of diameter at 100 represents substantially perfect symmetry of the reception characteristic for different positions of the plane of the loop antenna from 90° to 270°.

Such circles, 105 and 106, as shown with equal diameters and tangent to one another at the polar origin 100, indicate perfect symmetry of the entire system in respect to directional reception characteristics.

However, in practice with an ordinary loop antenna, the energy of reception for different positions of the plane of the loop is distorted and particularly distorted for the values proximate 90° and 270°, i. e., where the plane of the loop is substantially at right angles to the direction of propagation of the received radio waves. In Fig. 11 I have plotted similarly in polar coordinates the reception characteristics for different positions of the loop and designated the polar origin at 100, the extreme right hand diametrical value as 102 and the extreme left hand diametrical value as 101. Distortion or asymmetry as usually encountered principally with an ordinary loop antenna arranged and operated as heretofore proposed, is encountered at the location represented by the curved portion 107, for a range of position adjacent the values of 90°, and by the curved portion 108 for the values in advance of and following the proximate value of 270°. As will be noted the distortion represented by the curved portion 107 is of greater relative magnitude than the distortion represented by the curved portion 108. It will be noted that the diametrical value 100—102 of the right hand lobe 109 is less than the diametrical value 100—101 of the left hand lobe 110, and that the portions of the two lobes 109—110 above the axis 102—101 are not symmetrical with the portions of the two lobes 109—110 below the axis 102—101.

As I have discovered, by the use of my grid or harp of wires arranged and operated as disclosed hereinabove, in Figs. 5, 6, 7 and also in Fig. 9, when switches 91 and 86 are closed and switch 89 is opened, the curve representing the reception characteristic corresponds to that shown in Fig. 12, plotted similarly in polar coordinates having the origin at 100. The resulting two lobes 111 and 112 are of substantially duplicate and substantially symmetrical formation, the sole distortion being of relatively small value and closely proximate the values 90° and 270°.

The form of the two lobes 111 and 112 results by reason of the combination of the grid or harp of parallelly arranged wires and the loop antenna, coacting generally upon the detector or other radio receiving means of the receiving set.

In the normal operation of an ordinary

loop, it is practically impossible to obtain a zero of signal strength when the loop is proximate to 90° position with respect to the direction of reception, owing to the distortion of the directional characteristic; or if a zone of silence is obtained it extends over a relatively wide angle as is indicated by the limiting vectors 100—121, 100—122 of Fig. 11. Furthermore, such zone of silence is of different magnitude proximate to the 270° position of the loop, as indicated by the limiting vectors 100—123 and 100—124. Furthermore, these two zones of silence proximate respectively to the 90° and 270° positions of the loop are not 180° apart from one another thereby rendering it impossible to take a bearing on a distant transmitter with precision.

By my invention, as is indicated in Fig. 12, the zones of silence are restricted to the much closer limits indicated by the limiting vectors 100—125, and 100—126, proximate the 90° position, and by the vectors 100—127 and 100—128 proximate to the 270° position, and substantially 180° apart in position. And, if a zone of silence is not obtained but only a minimum of signal strength, the minima are more sharply defined as compared with those obtained with an ordinary loop, and substantially of equal intensity, as indicated by the vectors 100—113 and 100—129. Accordingly, my invention enables the bearing of the distant transmitter to be taken with precision.

In a similar manner, I have plotted in Fig. 13 to similar polar coordinates the form of the curves showing intensity of reception for different positions of plane of the loop with the arrangement shown in Fig. 9, under the condition of having the switches 91 and 89 in closed position and the switch 86 in open position, as hereinabove described. In such arrangement and manner of connection the curve of reception characteristics is nearly that of a circle comprising the curved portion 115 to the right of the vertical line 116, 117, and the curved portion 118 to the left of the vertical line 116, 117.

Practically speaking, the distortions of the curves 115 and 118 relative to a complete circle, are negligible and accordingly with the arrangement as shown in Fig. 9 with the switches 91 and 89 closed and the switch 86 open the intensity of the received energy for different positions of the loop antenna remains substantially constant and of maximum value.

With the arrangement shown in Fig. 9, however with the switches 91 and 86 open and the switch 89 closed, the intensity of reception for different positions of the loop corresponds to that shown by the curves in Fig. 14, where the origin is indicated at 100 and the right hand extreme diameter is indicated at 102 and the left hand extreme diameter is indicated at 101. The characteristic of the received energy accordingly shows two unequal minima indicated at 119 and 120 respectively and two unequal maxima indicated by the radius vector 100, 102 and 100, 101.

As will appear from a comparison of Fig. 14 with Fig. 11, the directional characteristic of the former figure is similar to that of the ordinary loop, as shown in the latter figure, but the asymmetry of the characteristic of the ordinary loop is enhanced by the particular use of my invention as described, thereby enabling the operator to determine the sense of the direction of the distant transmitter.

In Figs. 15 and 16, I have shown diagrammatically a practical form of apparatus embodying my invention and combining in simpler form the various instrumentalities set forth severally in the foregoing figures. I have indicated at 130 a set of parallelly arranged, substantially horizontally disposed wires, shown in side view in Fig. 15 and in end view in Fig. 16. One such grid employed by me contained seventeen such wires, each six feet long and spaced two inches from one another and mounted in a wooden frame, similarly as described hereinabove.

I have discussed the entire matter of the directional characteristics of loop antennæ and associated shielding harp or grid of wires in my paper before the Franklin Institute, entitled, "Theory and practical attainment in the design and use of radio direction finding apparatus using closed coil antennæ", which appeared in the Journal of the Franklin Institute, volume 188, No. 3, September, 1919.

The loop antenna indicated at 131 was in this case of the usual, square solenoidal type having a measurement of five feet on each side and containing six turns of No. 18 B. & S. gauge wire, spaced axially three eighths of an inch apart, mounted on a suitable frame in vertical position, the upper wire portions 132 and lower wire portions 133 being substantially horizontal and the two side wire portions 134 and 135 being substantially vertical. Such loop and the wire grid above described are practical for the reception of wave lengths of the order of 750 meters and for such wave length, the distance between the plane of the wire 130 and the plane of the wires 132 is most preferably three quarters of an inch.

The wires 130 are connected together by the cross wire 136 similar as hereinabove described and the conductor 137 leads from the cross wire 136 to the switch 138, comprising the movable contact connector 139 and the two contact points 140 and 141. The lead 142 connects the contact point 140 with one terminal 143 of the loop 131 and

with the terminal 144 of the receiver set 145.

The contact point 141 is connected by the ground wire 146 to ground indicated at 147.

The other terminal 148 of the loop 131 is connected by the lead 149 to the terminal 150 of the receiver set 145.

The various parts of the receiver set 145 correspond to those shown in Fig. 9 and like reference numbers are employed to indicate the same. It will be understood that the particular parts for the particular type of receiver set is determined by the order of the wave length received. the intensity of the received waves and other factors well known to those skilled in the art.

Upon closing the contact connector 139 of the switch 138 with its contact point 140 the grid element 130, 136 is connected electrically directly with the grid 65 of the vacuum tube receiver 64, whereby the apparatus is rendered substantially uniformly sensitive for the reception of waves for all positions of the loop and thereby the intensity of the received energy is at a maximum and obviates any adjustment of position of the loop antenna. This condition corresponds to the curve shown in Fig. 13.

Upon connecting the contact connector 139 of the switch 138 with the contact point 141, the grid element 130—136 is connected directly to ground at 147 and the apparatus as a whole is rendered highly sensitive for direction finding, the direction of the transmitting station being readily determined audibly through the telephone 79 in the usual manner. The relative intensity of received energy for different positions of the plane of the loop 131 corresponds to the relative energy intensity values shown in Fig. 12.

I claim:—

1. A receiving system comprising in combination with a loop antenna and a receiver set in radio reception, of means for controlling the directional properties of the receiving system and comprising two sets of wires disposed substantially parallel to one another and closely adjacent the loop antenna, a conductor interconnecting each set of said parallelly arranged wires and means for optionally connecting and disconnecting both sets of said parallel wires simultaneously with one another and with said receiver set, or simultaneously with one another and ground, or only one of said sets of parallel wires with said receiver set the other set of wires being entirely disconnected.

2. The combination with a loop antenna and a receiver set in radio reception, of means for producing an azimuthal reception characteristic of the system consisting of substantially two tangent circles for the purpose of giving sharp minima and symmetrical directional effect for different positions of the loop antenna, and comprising a plurality of sets of conductors disposed substantially parallel to a portion of said loop antenna and closely adjacent thereto for the purpose of producing a substantial shielding effect of the said loop antenna by said plurality of conductors, a conductor interconnecting said plurality of conductors and said last named conductor connected to the ground, and means for optionally connecting and disconnecting both sets of said parallel wires with one another and ground, or only one of said sets of parallel wires with said receiver set, the other set of wires being in this instance entirely disconnected.

3. A device for controlling the directional characteristics of a radio receiver, comprising a combination of a loop antenna and a plurality of sets of parallelly arranged conductors, said conductors being of substantially equal length and arranged closely adjacent to a portion of said loop antenna to provide an electrical shield to said loop antenna, and means for optionally connecting and disconnecting both sets of said parallel conductors with one another and ground, or only one set of said sets of parallel conductors with said receiver, the other set of conductors being in this instance entirely disconnected.

4. A device for controlling the directional characteristics of a radio receiver comprising a combination of a loop antenna and a plurality of sets of parallelly arranged wires arranged closely adjacent to said loop antenna to provide an electrical shield thereto, a wire electrically interconnecting said set of wires and a conductor connected to said interconnecting wire, and means for optionally connecting and disconnecting both sets of said parallel wires with one another and ground, or only one of said sets of parallel wires with said receiver set, the other set of wires being in this instance entirely disconnected.

In testimony whereof I affix my signature.

ALBERT S. BLATTERMAN.