

May 26, 1931.

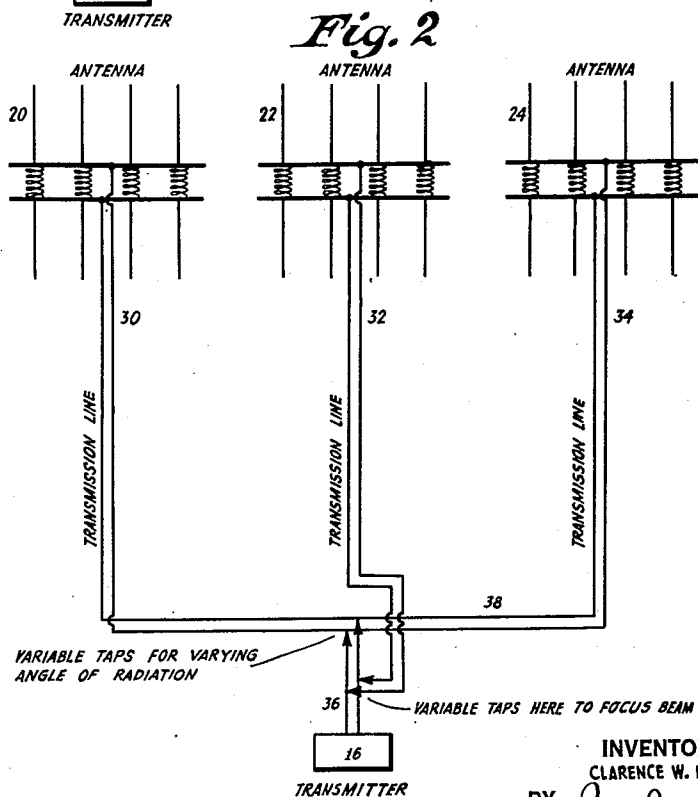
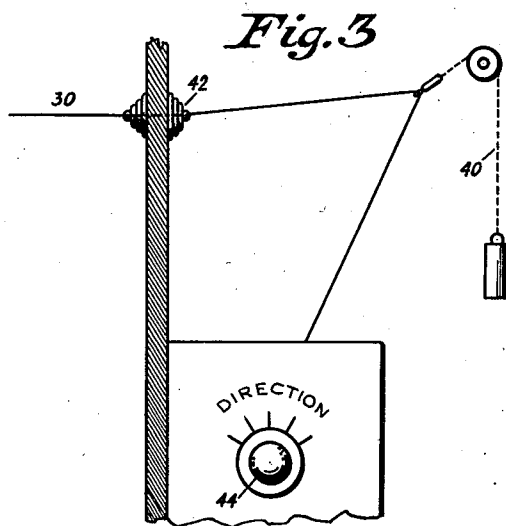
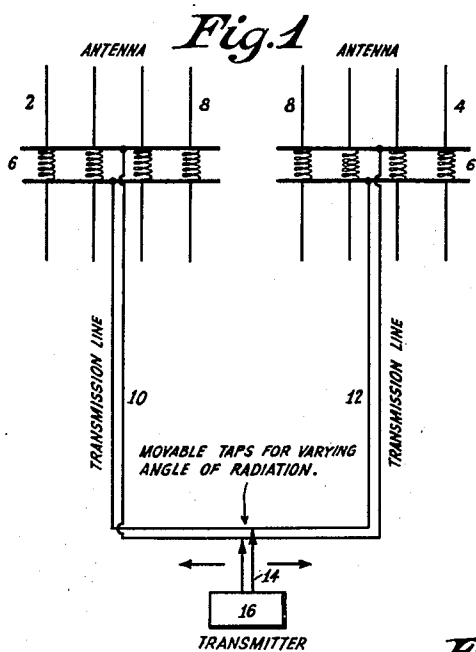
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1,806,755

ANTENNA

Filed Oct. 28, 1927

2 Sheets-Sheet 1



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Fig. 4

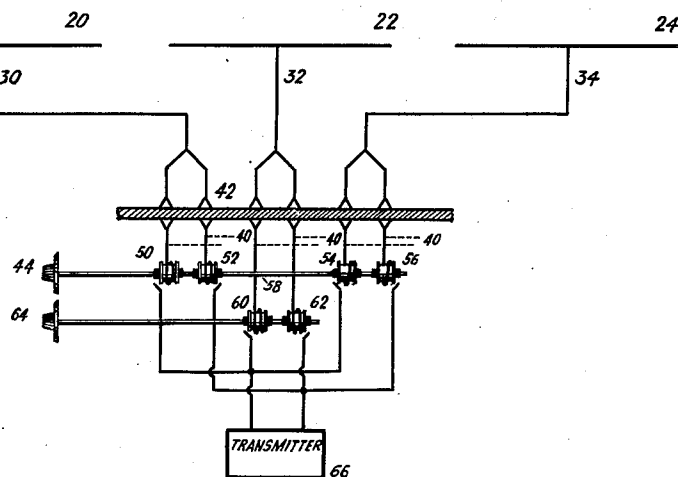


Fig. 5

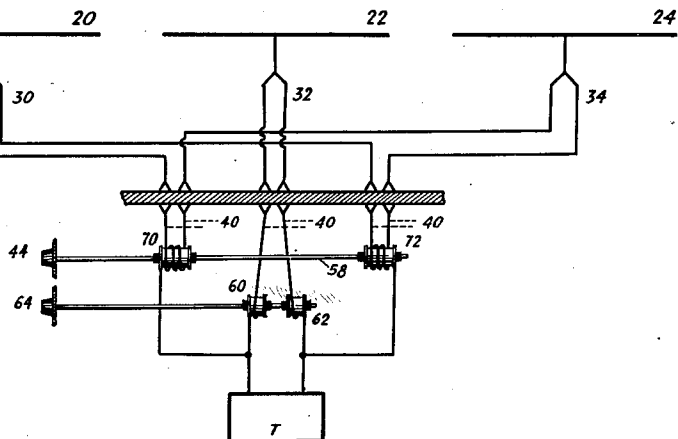
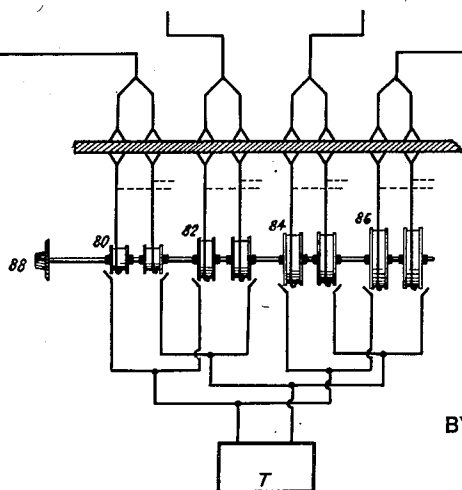


Fig. 6



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UNITED STATES PATENT OFFICE

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ANTENNA

Application filed October 28, 1927. Serial No. 229,294.

This invention relates to antennæ, and more particularly to a method and means for slightly varying the directivity of directive antennæ.

5 An antenna system may be sufficiently directive so that energy propagated from a station in the United States to a country in Europe is poorly received in other countries lying in different azimuthal directions, even
10 though the angular difference is relatively slight. For communication with the various countries without the inconvenience and expense of separate transmitting installations it is desirable that the directivity be subject,
15 when desired, to a slight variation or warping. To provide such an antenna system is an object of my invention, which I accomplish by providing antenna sections located relatively in broadside, and while keeping
20 the directivity of each section constant, I slightly vary the phase relations between the sections in order to warp the directivity slightly. More specifically, I provide a symmetrically branched system of transmission
25 lines for feeding the separate directive antennæ cophasially, but I provide means for varying the effective length of the lines to make the branches asymmetrical in order to shift the resultant direction of propagation
30 relative to the usual direction of transmission from the fixed antennæ.

It has been suggested that a transmitted beam be focused by slightly varying the phase relations of sections located in broadside symmetrically with respect to an axis lying in the
35 direction of transmission, and to provide means for so doing is a further object of my invention.

For varying the phase relations I vary the
40 effective length of the transmission lines feeding the antenna sections by winding a bare portion of the transmission line upon a rotatable metallic drum, and I provide means to take up the slack occasioned by rotation of
45 the drum.

The invention is described more in detail in the following specification, which is accompanied by drawings in which

50 Figure 1 indicates a system having two sections of broadside antennæ;

Figure 2 represents a somewhat similar system having three sections;

Figure 3 is an elevation showing one method for varying the effective length of a transmission line;

Figure 4 is a wiring diagram for a triple
55 broadside antenna arranged for warping and focusing a transmitted beam;

Figure 5 is an alternative arrangement;
60 and

Figure 6 indicates an arrangement which may be used for warping the directivity of an antenna provided with any desired number of sections.

Referring to Figure 1 there are two sections of broadside directive antennæ 2 and
65 4, each consisting of feeder members 6 and transverse radiators 8. For a more detailed description of such antennæ a copending application of Nils E. Lindenblad, Serial No.
70 229,407, filed on even date herewith, may be referred to.

In accordance with my invention instead of providing one large broadside antenna I provide two sections, as indicated, and these are
75 fed by symmetrically branched transmission lines 10, 12, and 14, which lead to a source of transmission energy 16. The junction point of the line 14 with the lines 10 and 12 is made variable and it is readily seen that by its
80 movement the lines 10 and 12 are made relatively longer or shorter, thereby slightly varying the relative phase of the antennæ sections 2 and 4, which results in a warped resultant directivity.
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In Figure 2 there are three sections 20, 22, and 24, fed by transmission lines 30, 32 and 34, which normally are symmetrically branched, that is, the length of transmission line from the transmitter 16 to the antenna
90 sections is electrically equal or different by full wave lengths. It is clear that by shifting the point of junction of the line 36 with the lines 30 and 34 the latter are relatively lengthened or shortened while the length of
95 the line 32 is unaltered, so that the resultant directivity will be warped, just as in the arrangement shown in Figure 1.

The line 32 has been shown connected with the line 36 by a variable junction point, which
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serves as a means for focusing the transmitted beam of energy. This is not part of my invention, being described and claimed in the application of Nils E. Lindenblad before referred to, but is here disclosed merely to show that warping of the directivity and focusing of the width of the transmitted beam may be employed in combination in a very simple manner.

In Figure 3 there is shown a transmission line conductor 30, brought through a wall insulator 42, and then led to a drum the shaft of which is rotated by means of a dial 44, the scale for which may be calibrated in direction, or degrees of warping, or in terms of the receiving stations towards which the transmitted beam is directed. To take up the slack provided by rotation of the drum there is a tension cord 40, the operation of which is clear from the drawing.

In Figure 4 there is indicated a triple broadside antenna, comprising the sections 20, 22 and 24, fed by transmission lines 30, 32 and 34. These have been shown as single lines for the sake of simplicity, but the two wires from each are shown passing through the station wall by means of insulators 42. The wires of line 30 are wound upon drums 50 and 52 in one direction, while the wires from 34 are wound upon drums 54 and 56 in the opposite direction. These drums are all mechanically mounted upon a single shaft 58, but are electrically insulated therefrom. The dotted lines 40 indicate the arrangement for taking up the slack, shown more in detail in Figure 3. Rotation of the dial 44 varies the effective length of the lines 30 and 34 equally and oppositely relative to the length of the line 32 and consequently warps the resultant directivity.

If it is desired to focus the transmitted beam, in accordance with the invention described and claimed in the application of Nils E. Lindenblad before referred to, it is merely necessary to provide the conductors of the line 32 with drums 60 and 62, actuated by a focusing control 64, as is indicated in the drawing. Conductors from the corresponding drums are joined and lead to a transmitter 66.

In Figure 5 there is shown a slightly different alternative arrangement in which the wires from the lines 30 and 34 of like polarity are led to drums 70 and 72, and so wound thereon that the drums merely give the conductors traction, that is, the shortening of one lead provides a cable for the lengthening of the other lead. As before, the individual slack of the wires is taken up by the tension means 40, and, if it is desired to focus the transmitted beam, focusing drums 60 and 62 with a dial 64, may be provided.

It is clear that while three sections form a convenient arrangement yet there is no reason why the invention, in best form, should

not have a great many more sections. This will necessitate a slightly different form of drum mechanism, and to illustrate this an arrangement for warping an antenna having four sections, but which is equally applicable to an antenna having any number of sections, is indicated in Figure 6, in which the conductors are wound in the same direction upon drums 80, 82, 84 and 86, which are made with different diameters which increase in linear proportion. The conductors are so arranged that at a mean position of the dial 88 the transmission lines have equal effective lengths. It is then clear that rotation in one direction or the other will warp the resultant directivity in either direction.

Of course, an arrangement analogous to Figure 4 may be provided, in which the transmission lines are wound in opposite directions on pairs of drums which increase in stepped-up ratio. Thus, with eight sections, there may be provided either eight sets of drums of different diameters, or two sections of drums such as are indicated in Figure 6, with four of the transmission lines being wound in one direction, while the other four are wound in the opposite direction.

It is to be understood that my invention, in so far as it applies to warping and directivity, is equally applicable to forms of directive antennae having fixed directions of propagation other than the broadside antenna, such as the end-on antenna described in a copending application of Nils E. Lindenblad, Serial No. 229,408, filed on even date herewith, and that the phase variation may be accomplished electrically, instead of mechanically, as by varying the magnitude of series reactances.

It is also to be understood that the invention, in so far as it applies to varying phase by varying the effective length of transmission lines, is applicable to warping antennae of any number of sections, or to focusing antennae of any number of sections, even including the ultimate case in which each section reduces to a single non-directive radiator.

I claim:

1. The method of warping the directivity of a broadside directive antenna comprising a large number of nondirective radiators disposed along a line substantially at right angles to the direction of transmission which includes exciting adjacent radiators in groups of radiators cophasially, and exciting the groups of radiators in slightly different phase relation in order to warp the resultant directivity.

2. A directive antenna comprising a plurality of radiating sections located substantially in line and relatively in broadside, a source of transmission energy, means to feed the sections from the source substantially cophasially, and means to slightly relatively

vary the phase relations between the sections in order to warp the directivity of the antenna.

3. A directive antenna comprising a plurality of sections of broadside radiators located relatively in broadside, a source of transmission energy, means to feed the sections from the source in slightly variable phase relation, and means to feed the radiators in each section cophasially.

4. A directive transmission antenna system comprising a plurality of directive antennae having similar fixed directions of propagation and located substantially in line and relatively in broadside, a source of transmission energy, and means to feed the directive antennae from the source in slightly variable phase relation in order to warp the directivity of the antennae.

5. A directional antenna comprising sections having fixed directivities, symmetrically branched transmission lines for coupling the sections, and means for varying the physical length of the lines to make the branches asymmetrical in order to warp the directivity of the antenna.

6. A directive antenna system comprising a plurality of directive antennae having fixed directions of propagation and located relatively in broadside, a source of transmission energy, symmetrically branched transmission lines for feeding the antennae from the source, and means for varying the effective lengths of the lines to make the branches asymmetrical in order to warp the resultant direction of propagation.

7. A directive antenna comprising broadside sections of radiators located relatively in broadside, a source of transmission energy, branched transmission lines for feeding the sections from the source, means to excite the radiators in each section cophasially, and means for varying the effective lengths of the lines to make the branches asymmetrical in order to warp the directivity of the antenna.

8. In combination, an antenna, a transmission line coupled to said antenna and including a bare transmission line portion, a metallic drum upon which said portion is wound, means to rotate said drum to vary the effective length of the line in order to vary the phase of the energy of the antenna, and means to take up the slack occasioned by rotation of the drum.

9. In combination, a plurality of aerials, a plurality of transmission lines coupled thereto each including a bare transmission line portion, a plurality of metallic drums upon which said portion is wound, means to rotate said drums to differently vary the effective lengths of the lines in order to relatively vary the phase of the energies of the aerials, and means to take up the slack occasioned by rotation of the drums.

10. In combination, a plurality of bare transmission line portions, a plurality of metallic drums upon which said portions are so wound that equal rotation causes unequal changes of length, a shaft connecting said drums mechanically but not electrically, means to rotate said shaft to differently vary the effective lengths of the lines, and means to take up the slack occasioned by rotation of the drums.

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