July 25, 1950 E. A. LAPORT 2,516,706

ANTENNA SYSTEM

Filed May 23, 1947 2 Sheets-Sheet 1

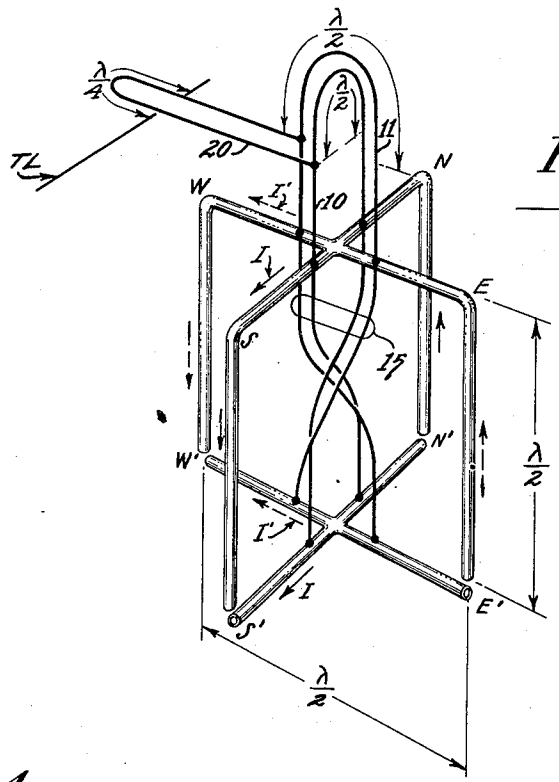
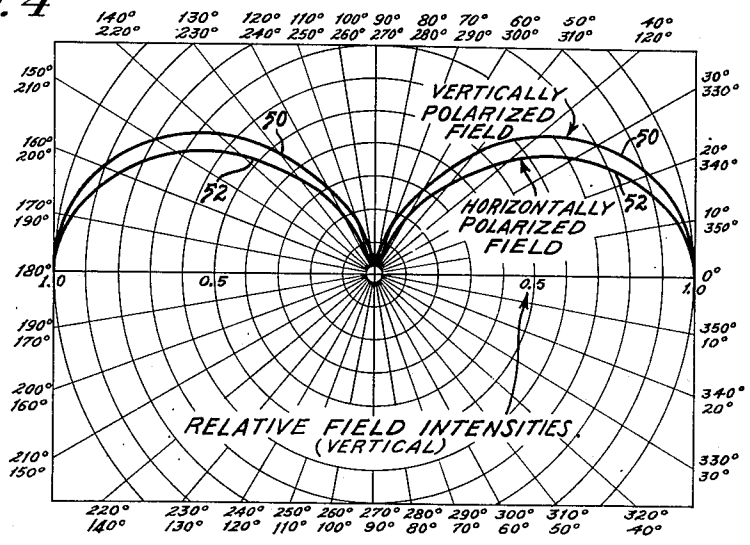


Fig. 1

Fig. 4



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Fig. 2

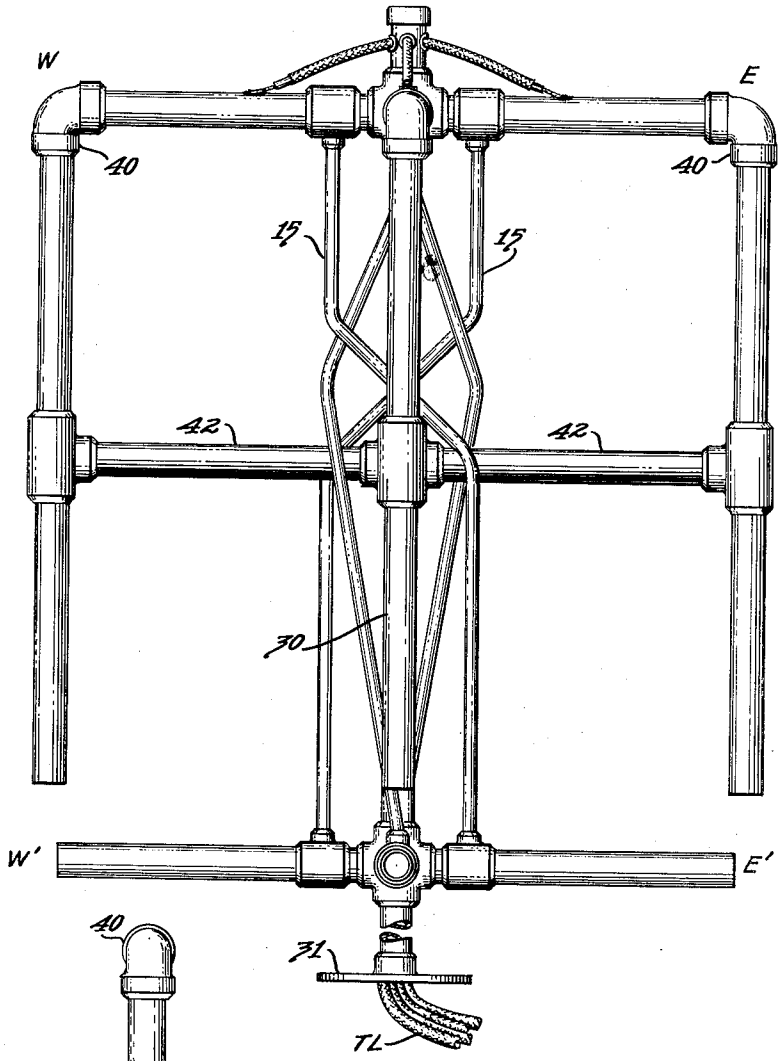
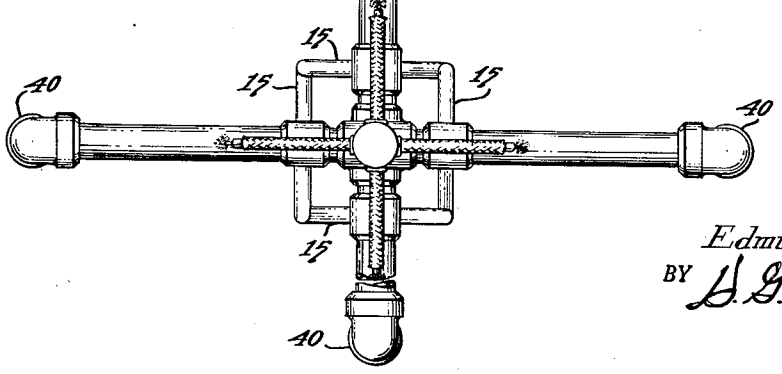


Fig. 3



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ANTENNA SYSTEM

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5 Claims. (Cl. 250—33)

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The present invention relates to antenna systems and more particularly to an antenna system for radiating a substantially uniform field in all directions toward the horizon and with substantially equal components of vertical and horizontal polarization.

An object of the present invention is to provide an antenna system for simultaneously radiating vertically and horizontally polarized energy.

Another object of the present invention is the provision of an antenna system as aforesaid which radiates both fields substantially uniformly in all directions toward the horizon.

Another object of the present invention is to provide a novel form of broadcast antenna.

Still another object of the present invention is to provide a very high frequency antenna suitable for radiating airport traffic control signals.

Still a further object of the present invention is the provision of an antenna system for simultaneously radiating vertically and horizontally polarized energy, said antenna being simple and rugged in construction.

The foregoing objects and others which may appear from the following detailed description are attained by providing a turnstile antenna arrangement having both vertical and horizontal radiating elements. The radiating elements are so energized as to radiate a rotating field of substantially uniform amplitude in all horizontal directions.

The present invention will be more fully understood by reference to the following detailed description which is accompanied by a drawing in which:

Figure 1 illustrates in perspective view a simplified arrangement of an antenna utilizing the principles of the present invention, while

Figure 2 is an elevational view of the antenna of the present invention, and

Figure 3 is a plan view thereof, while

Figure 4 is a representation of the radiated field distribution for both vertically and horizontally polarized fields.

Referring now to Figure 1 there is shown a pair of crossed horizontal dipoles NS and WE. The dipole NS is fed near its center point by a transmission line loop 10 of any convenient length. To a selected point on loop 10 is connected one end of a second loop 20, the point of connection of said second loop being so chosen that the differential lengths of the conductors of loop 10 from the said selected point of connection to the arms of dipole NS is a half wavelength. Thus, the two arms of the dipole NS are fed to phase

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opposition. A similar loop 11, having a similar half wave differential in lengths of connection from its point of connection to loop 20 to the arms of dipole WE, similarly energizes the arms of dipole WE in phase opposition. The antenna is fed from a suitable source of energy, not shown, by a transmission line TL connected to a point on loop 20 such that the differential conductor length from the point of connection of line TL to the loops 10 and 11 is a quarter wavelength. Thus, the dipole NS is fed in a phase quadrature relationship to the dipole WE. A rotating horizontally polarized field is, therefore, radiated from the turnstile comprised of the crossed dipoles NS and WE. It should be noted that, in connection with the foregoing description, for the sake of simplicity, the inner conductors only of the concentric transmission lines, forming loops 10, 11 and 20, have been shown. Ordinarily in practice, these conductors will be surrounded by concentrically arranged grounded conductive sheaths. Now, in order to compress the radiation into a narrow vertical angle, a second pair of crossed dipoles N'S' and W'E' is provided. These are arranged parallel to the first mentioned dipoles NS and WE and energized in an in-phase relationship as indicated by the arrows I and I'. The arrows I' are shown dotted in order to indicate that while the currents in dipoles WE and W'E' are in phase with each other they are not in an in-phase relationship with currents I in dipoles NS and N'S' but rather in a phase quadrature relationship. Now, considering the dipole NS and the dipole N'S', these dipoles are spaced a half wave apart in a vertical plane and are energized in an in-phase relationship. Thus, they act as a simple broad-side array and tend to compress the vertical angle of radiation. The same effect takes place with respect to the dipoles WE and W'E'. Phasing conductors 15 are provided connecting the dipoles NS and WE to the dipoles N'S' and W'E'. Since the conductor lengths of the phasing conductors 15 are of the order of a half wavelength, they must be crossed as indicated in order to insure the correct phase relationship of the currents in the dipoles. Now, in order to provide an equal component of vertical radiation, the four vertical dipoles NN', WW', SS' and EE' are provided. They are each conductively connected at one end, in the present case, the upper end, to one of the horizontal turnstile elements whereby they are energized by direct conduction therefrom. Now, at any given instance, vertical dipole NN' is energized in an anti-phase relationship with the

vertical dipole SS'. The two dipoles being spaced a half wave apart, they act as a simple end-fire array compressing the radiation in a direction in the plane of dipoles. However, as the four vertical dipoles are energized in progressive phase quadrature relationship, the radiation pattern rotates in a horizontal plane at the frequency of the radiated wave and a substantially uniform rotating field of vertically polarized energy is provided.

The actual mechanical construction of an antenna constructed according to the principles of the present invention is shown in Figure 2. It will be seen that all of the radiating elements are constructed of hollow pipe and fittings whereby the entire structure may be electrically grounded for protection against lightning strokes. The dipole WE is supported at its midpoint by a tubular metal supporting pole **30** provided at its lower end with a suitable mounting flange **31**. The transmission lines TL, by means of which the antennas are energized, pass vertically through the supporting pole **30** and out through suitable apertures at the top end thereof where their inner conductors are attached at points along the lengths of the dipoles such that the impedance of the dipoles is matched to the impedance of the transmission line loops. The vertical radiators are conductively connected to the upper horizontal dipole by elbow fittings **40** and are supported at their voltage nodal points near their centers by conductive tubular members **42** securely attached to the supporting pole **30**. The arrangement of the phasing conductors **15** by means of which the lower turnstile is energized from the upper turnstile is more clearly shown in Figure 2 than in the simple diagrammatic representation in Figure 1. The interlacing of the conductors **15** to provide the correct phase relationship and to avoid the conductive supports **42** is apparent from the drawing.

A calculation of the antenna shown in Figures 2 and 3 resulted in the radiation pattern in Figure 4. Curve **50** shows the relative amplitudes of the vertically polarized field for varying angles of elevation while curve **52** similarly depicts the distribution of the horizontally polarized field in the vertical plane. In the horizontal plane, both fields are substantially circular in pattern so no graphical representation is necessary.

While I have illustrated a particular embodiment of the present invention, it should be clearly understood that it is not limited thereto since many modifications may be made in the several elements employed and in their arrangement and it is therefore contemplated by the appended claims to cover any such modifications as fall within the spirit and scope of the invention.

What is claimed is:

1. An antenna system including a first pair of crossed dipole radiators supported at its midpoint on a vertical conductive mast, a second pair of crossed dipoles supported at its midpoint on said mast at a distance equal to a half of the operating wavelength from said first crossed dipoles, means for feeding said first pair of crossed dipoles with radio frequency energy in a phase quadrature relationship whereby a rotating horizontally polarized field is radiated, means for feeding said second pair of crossed dipoles from said first pair and a vertically arranged dipole connected to each end of each of said first pair of crossed dipoles whereby said vertically arranged dipoles are arranged to radiate a vertically polarized rotating field.

2. An antenna system including a first pair of crossed dipole radiators supported at its midpoint on a vertical conductive mast, a second pair of crossed dipoles supported at its midpoint on said mast at a distance equal to a half of the operating wavelength from said first crossed dipoles, means for feeding said first pair of crossed dipoles with radio frequency energy in a phase quadrature relationship whereby a rotating horizontally polarized field is radiated, means for feeding said second pair of crossed dipoles from said first pair and a vertically arranged dipole connected to each end of each of said first pair of crossed dipoles whereby said vertically arranged dipoles are arranged to radiate a vertically polarized rotating field, said first pair of crossed dipoles being above said second pair and said vertically arranged dipoles depending from said first pair of crossed dipoles.

3. An antenna system including a vertical conductive mast, a group of dipole radiators arranged in cruxiform and supported on said mast, a second group of dipoles arranged in cruxiform and supported on said mast at a distance equal to a half of the operating wavelength from the first mentioned dipoles, means for feeding said first group of dipoles with radio frequency energy in a phase quadrature relationship whereby a rotating horizontally polarized field is radiated, conductors arranged for feeding said second group of dipoles from said first group of dipoles, and a vertically arranged dipole connected to the outermost end of each of the dipoles of said first group whereby said vertically arranged dipoles radiate a vertically polarized rotating field.

4. An antenna system including a first group of dipole radiators supported at one end on a vertical conductive mast, a second group of dipoles supported at one end on said mast at a distance equal to a half of the operating wavelength from said first group of dipoles, the dipoles of said groups being arranged in cruxiform, means to apply radio frequency energy in a phase quadrature relationship to the dipoles of said first group whereby a rotating horizontally polarized field is radiated, conductors tapped onto the dipoles of said second group of dipoles at points intermediate the ends thereof and arranged to apply energy thereto from the dipoles of said first group, and a vertically arranged dipole connected to the outermost end of each of the dipoles of said first group whereby said vertically arranged dipoles radiate a vertically polarized rotating field, said first group of dipoles being above said second group and said vertically arranged dipoles depending from said first group of dipoles.

5. An antenna system including a vertical conductive mast, a group of dipoles supported at one end on said mast in conductive relationship thereto and extending outwardly therefrom for a distance of substantially a quarter of the operating wavelength, a second group of dipoles supported at one end on said mast in conductive relationship thereto and extending outwardly therefrom for a distance substantially a quarter of the operating wavelength, said first group of dipoles being above said second group, means to connect a conductor of a transmission line to the dipoles of said first group at points intermediate their ends to apply radio frequency energy in a phase quadrature relationship whereby a rotating horizontally polarized field is radiated, conductors interconnecting points on the dipoles of said first

group intermediate the ends thereof with points on said second group intermediate the ends thereof to feed said second group of dipoles from said first group and a vertically arranged dipole connected to the outermost end of each of the dipoles of said first group whereby said vertically arranged dipoles are arranged to radiate a vertically polarized rotating field, said vertically arranged dipoles depending from said first group of dipoles.

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REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
2,197,051	Lindenblad	Apr. 16, 1940
2,210,491	Lewis	Aug. 6, 1940
2,217,911	Lindenblad	Oct. 15, 1940
2,338,564	Aram	Jan. 4, 1944
2,416,246	Wheeler	Feb. 18, 1947
2,426,632	Marchand	Sept. 2, 1947