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RADIO DIRECTING AND DIRECTION FINDING SYSTEM

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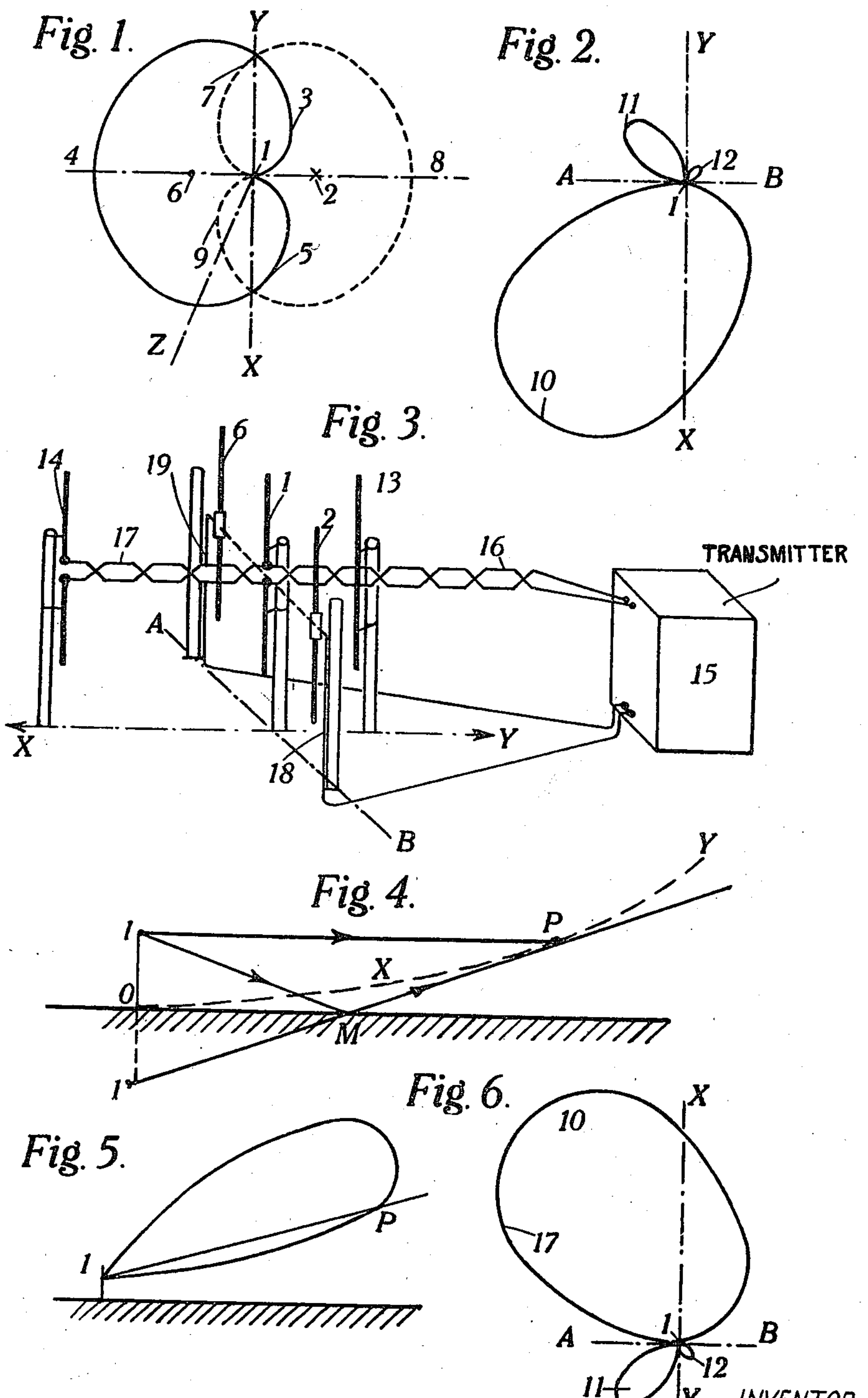

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RADIO DIRECTING AND DIRECTION FINDING SYSTEM

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The present invention relates to improvements in radio direction finding or guiding systems, for example, systems for the blind landing of aeroplanes in fog, in which the distribution of the electromagnetic field is employed to guide the moving body which is provided with a device sensitive to the electromagnetic waves.

In particular, the object of the invention is the provision of means for eliminating the effect of parasitic influences which tend to alter the desired distribution of the electromagnetic field. For this purpose it is suggested according to the invention to provide novel arrangements of radiator elements and novel arrangements for feeding such radiator elements.

According to one feature of the invention a directive antenna system comprises a central dipole antenna, a reflector dipole arranged parallel to the central dipole antenna on one side thereof and spaced therefrom a distance equal to a quarter of the operating wave length and a directing dipole antenna disposed on the other side of the central dipole antenna at a distance from it equal to one half of the operating wave length.

This and other features of the invention will be more clearly appreciated from a reading of the following description in conjunction with the accompanying drawing in which:

Fig. 1 represents a polar diagram of the distribution of the electromagnetic field in a horizontal plane such as is obtained with known antenna systems comprising a vertical dipole and associated reflector;

Fig. 2 represents a polar diagram in the horizontal plane of the electromagnetic field obtained by an antenna system according to the present invention;

Fig. 3 represents one method of carrying out the invention for obtaining a radiation diagram similar to that of Fig. 2;

Fig. 4 shows schematically how the ground reflection of the waves is employed for guiding the moving body in a vertical plane;

Fig. 5 represents a form of radiation diagram producing the same results without employing ground reflection;

Fig. 6 shows in polar coordinates in the vertical plane the distribution of the electromagnetic field obtained by an antenna device according to the present invention.

In known systems employed for the directional guiding of a moving body, a vertical antenna 1 is frequently employed associated with a vertical reflector 2 placed at a suitable distance from this antenna; this unit produces in the horizontal plane a diagram of field distribution of a form similar to that of curve 1, 3, 4, 5 of Fig. 1.

If the known system in which the reflector 2 and another reflector 6 are successively keyed or rendered operative, is applied to the diagram of Fig. 2, it will be seen that the direction 1, X is marked by the equality of the signals, but that the undesired direction 1, Y will be marked out since no signal is radiated in this direction. It will also be seen that the backward radiation of the emitter with respect to the marked axis is very low with respect to the useful radiation in the direction 1, X. The result is that if reflections are produced by this secondary radiation they will only have negligible disturbing effects with respect to the main radiation in the direction 1, X.

For example, the diagram of Fig. 2 which was obtained in the case of an antenna arrangement of the kind which will be described later, has two loops of secondary radiation 11 and 12 whose maxima amplitudes in one embodiment were respectively 9 and 25 decibels above the radiation in the desired direction 1, X. Moreover, the secondary radiations 11 and 12 have substantially the same angle of opening between their tangents to the origin so that wrong indications of direction obtained in the course of the manipulation represent field values far below the maximum amplitude of the smallest of the components, that is to say which is below 25 decibels with respect to the main marked axis 1, X.

If the metallic or other obstacles cause reflections of the radiation backwards such as 11 or 12, it will be seen that the disturbing effects will be very weak with respect to the main effect in the direction 1, X.

Fig. 3 shows one embodiment of the invention. There is provided a main or central antenna 1 with a rear reflector 13 at a distance equal to a quarter of the working wave length and with another front antenna or director 14 placed at a distance equal to half the working wave length of the main antenna 1. This set of antennae and reflectors is fed by a suitable source 15 with modulated or unmodulated high frequency current by means of a transmission line 16, 17 arranged or provided with means whereby disturbing radiations of the line due, for example, to the presence of currents induced in the line by the field of the antennae, are prevented. Such currents have the effect of superposing on the main field of the antennae a harmful field of indeterminate intensity and phase which finally produces distortion of the diagram sought.

In the example shown in Fig. 3, the transmission line 16, 17 is placed in the symmetrical axis of the antennae so that any disturbance caused by the line in the main field would be symmetrically produced during the successive periods of keying or manipulation and consequently would be eliminated.

Moreover, means are employed for eliminating the currents circulating in phase in the two line wires and by way of example for this purpose transpositions of line wires at intervals have been shown, but it is clear that any other means serving for the elimination of such disturbing currents could be employed.

With the same object of eliminating the disturbing currents as shown in Fig. 3 the transmitter 15 is placed behind the antennae in a direction corresponding to 1, Y of Fig. 2 where the radiation is zero. It will further be seen that the cables 18 and 19 over which the keying relays of the reflectors are controlled are placed in such directions at 1A and 1B of Fig. 2 which correspond also to substantially zero radiating fields so that the conductors 18 and 19 have substantially no harmful effect on the main radiation.

It will be noted that associated with the antenna 1 are reflectors such as 2 and 6 placed respectively at a quarter of the working wavelength from the antenna 1. These reflectors 2 and 6 are employed to deform the radiation diagram in the rhythm of the keying by means of relays in known manner.

Fig. 4 shows a beam 1M emanating from an antenna 1 and reflected by ground at the point M in the direction MP. The field at the point P results from the superposition of the field directly transmitted in accordance with the line 1P and of the field reflected in accordance with MP.

The geometric position of the point P where the electromagnetic field has the same value, is a curve shown as OX tangential to the ground at the point O situated vertically below the antenna 1. The effect is the same as if there were associated with the antenna its image 1' with respect to ground. This known phenomenon has been employed in order to obtain a guiding path for a moving object such as P, in accordance with a constant field curve. It will, however, be seen that any irregularity in the reflection to ground will cause irregularities in the guiding trajectory OXP, and if objects such as houses, hangars, trees, etc., are situated at the point M, the disturbances of the trajectory may be considerable. These harmful effects are largely avoided if a vertical radiation diagram such as that shown in Fig. 5 is employed. This diagram is characterized by the fact that the radiation in the direction of the ground is zero and that consequently irregularities of reflection are avoided, the guiding trajectory being only produced by the direct radiation of the antenna 1 towards the point P indicating the moving object to be guided.

An antenna device similar to that of Fig. 3, permits a vertical radiator diagram to be obtained similar to that of Fig. 5.

Referring to Figs. 2 and 3 it will be seen that it is sufficient to mount the antenna 1 horizontally, the reflector 13 horizontally and at a quarter of a wavelength below the antenna 1, and the director 14 above the antenna 1 and at half a wavelength distance. A further horizontal reflector 2 is placed at the same height as the antenna 1 and a quarter of a wavelength behind. The reflector 6 of Fig. 3 is not in this case installed.

Under these conditions a diagram is obtained such as that of Fig. 6 in which a moving body proceeding from the direction 1A is guided by a trajectory 10, 17, 1 arriving tangentially to ground represented by the straight line A,1,B.

Secondary reflection effects on the ground may be produced by the radiation of the loop 11, but the amplitude of the loop 11 being weak with respect to the amplitude of the main radiation 10, these secondary effects are negligible. Moreover, the horizontal direction 1A corresponds to a direction of zero radiation for the loop 11. It follows that the secondary effects produced by the radiation 12 are negligible in the directions near the horizontal and only assume appreciable value for sufficiently large angles with respect to the horizontal. These angles correspond to the normal guiding trajectory 10, 17, 1 to points very near the antenna 1, that is to say, in practice the reflection effects of the radiation 12 are entirely negligible.

With regard to the vertical guiding of the moving object, it will be noted that the latter has to follow a constant field curve; if it be at too high an altitude it receives an electromagnetic field greater than the normal value; on the other hand, if it be at too low an altitude the field received is lower than the normal value.

It is desirable in certain cases for the guiding indications to be supplied to the pilot by other means than the visual means, for example, by sound indications.

In one of the embodiments proposed in the invention the intensity of the signals controls the frequency of an audio frequency oscillator, so that an increase of frequency is obtained when the electromagnetic field is greater than the normal value, that is to say, when the moving body is below the trajectory of vertical guiding. Conversely, a reduction of frequency characterizes too low an altitude.

This frequency variation may be shown by known visual apparatus such as frequency meters. If a sound indication be desired it is convenient to compare the variable frequency obtained by the above means with a frequency of fixed basis. It is possible, to employ as comparison frequency, the modulation frequency of the fixed ground transmitter.

In order to render the above device more sensitive, it is possible to obtain the audio frequency variable by the interference between a fixed high frequency oscillator and a second high frequency oscillator controlled as explained above. The fixed frequency oscillator may be the heterodyne oscillator of the receiver if the latter comprises one.

The invention is not limited to the specific arrangements which have been described and modifications coming within the scope of the appended claims will readily occur to those versed in the art.

What is claimed is:

1. A directive antenna system comprising a central dipole antenna, a reflector dipole antenna parallel to said central dipole and spaced therefrom a distance equal to a quarter of the operating wave length, a directing dipole antenna disposed on the opposite side of said central dipole at a distance therefrom equal to one half of the operating wave length, and a common transmission line for feeding said central and directing dipoles extending along the symmetrical axis of the three antennas.

2. A directive antenna system as defined in claim 1 and in which the transmission line is connected with a transmitter located behind the reflector dipole in line with said symmetrical axis.

3. A directive antenna as defined in claim 1, and in which the conductors of the transmission line are transposed at intervals along the length thereof.

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