April 25, 1950 H. M. WAGNER 2,505,017

BEACON SYSTEM

Filed Oct. 16, 1945

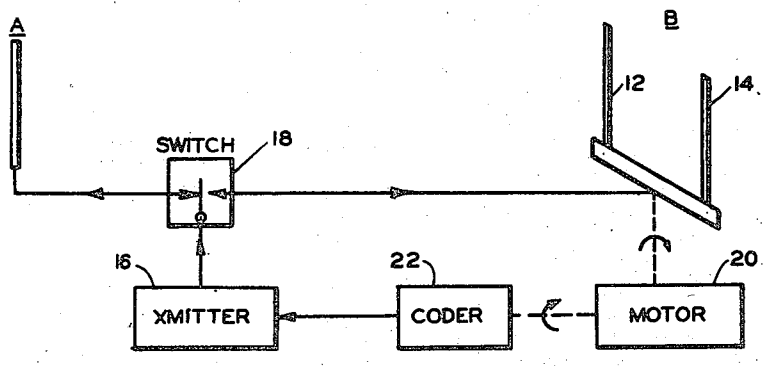


FIG. 1

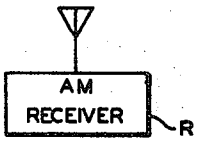


FIG. 3

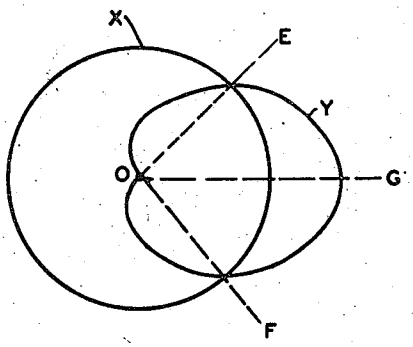


FIG. 2

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Patented Apr. 25, 1950 2,505,017

UNITED STATES PATENT OFFICE

2,505,017

BEACON SYSTEM

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Application October 16, 1945, Serial No. 622,646

8 Claims. (Cl. 343—106)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

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The invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment to me of any royalty thereon.

This invention relates to directional signaling systems, particularly to a system of the type suitable for use as a radio beacon. Systems of this type, in general, use a directional antenna, and bearing is determined by means of an amplitude modulation receiver which detects changes in field strength of said antenna. The bearing accuracy, therefore, depends upon the sharpness of the antenna directivity. Where said antenna is of the figure-of-eight or cardioid type, the directivity is relatively broad whereby accurate bearing determination is difficult to obtain.

It is a principal object of this invention to provide a beacon system which permits more accurate bearing determination even if the overall response pattern of the antenna system is broadly directional.

For a better understanding of the invention, together with other and further objects thereof, reference is had to the following description taken in connection with the accompanying drawing wherein:

Figure 1 is a block diagram of the invention;

Figure 2 is a diagram illustrating the operation of the invention; and

Figure 3 is a block diagram of an amplitude modulation receiver adapted to be used with the invention.

Referring now to the drawing, there are shown a nondirectional antenna A, consisting of a vertical rod having a circular radiation pattern, as shown at X in Fig. 2, and an antenna array B including at least a pair of coplanar rod antennas 12 and 14, preferably arranged in a manner well known in the art to provide a cardioid radiation pattern as shown at Y, although an antenna having a figure-of-eight or any other type of symmetrical, directional radiation pattern can be used.

Antennas A and B are alternately connected to the output of a transmitter 16 by means of a continuously operating switch 18, which may be of the electronic type or motor-driven mechanical type.

Directional antenna B is continuously rotated in azimuth by means of a motor 20 so that the effective orientation of the radiation pattern is continuously rotated. Also rotated by motor 20, in synchronism with the antenna rotation, is a coder 22 which imparts to the output of transmitter 16 a characteristic modulation which is

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indicative of the effective orientation of the radiation pattern of the antenna. Coder 22 may take any known form. One form of coder commonly used imparts a distinct code letter for each orientation or increment thereof. Thus the code letter heard at any instant in the output of a receiver R situated in the operating field of the beacon will indicate the effective orientation of the antenna pattern.

Preferably, switch 18 is operated at such speed that succeeding code letters are radiated alternately through antennas A and B. For this purpose, switch 18 may be synchronized with the coder 22, and may be driven or controlled by motor 20. With such mode of operation, it will be seen that the field intensities of the signals from both antennas will be equal along lines O—E and O—F where the radiation patterns of antennas A and B intersect. Thus, an amplitude modulation receiver positioned along line O—G, for instance, will, as the cardioid antenna B rotates, detect two pairs of successive code signals, with the signals of each pair having equal intensities, as lines O—E and O—F pass through the line of reception. From the code letter accompanying each pair of signals, the operator will know in which direction the cardioid was pointing when each pair of equal-intensity signals was heard. This will enable him to determine his bearing, since it will be the bearing of the line intermediate the lines O—E and O—F, i. e., the line O—G.

From Fig. 2, it will be seen that, contrary to the usual practice of bearing determination by determining the null or maximum signal condition, the bearing is determined by an equi-signal condition which occurs at the sides of the radiation pattern Y where the rate of change of signal voltage is much greater than that at the nose of the radiation pattern and the amount of radiation is sufficient to permit use of receivers having ordinary sensitivity. This permits use of antennas having relatively broad directional patterns and still permits relatively sharp direction discrimination.

While there has been described what is at present considered a preferred embodiment of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and it is aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. The method of radio ranging which com-

prises establishing at one location a radio beacon by alternately transmitting a given signal nondirectionally and directionally, and continuously and progressively rotating the effective direction of the directional transmission, and determining the bearing of another location by receiving alternate transmissions from said beacon and comparing the intensities thereof.

2. The method of radio ranging which comprises establishing a radio beacon by alternately transmitting a signal through a nondirectional antenna and a directional antenna having a cardioid radiation pattern, continuously rotating the effective orientation of said radiation pattern, impressing a distinctive code letter on said signal with each change in orientation of said radiation pattern, and determining the bearing of a point by receiving at said point in succession two pairs of code letters from said beacon having substantially equal intensities, and determining from the code letters accompanying said pairs of signals the effective direction along which said radiation pattern is oriented.

3. A radio ranging system comprising, in combination, a beacon including a nondirectional antenna, a directional antenna, a radio wave generator, means for alternately coupling the output of said generator to said antennas, and means to continuously and progressively rotate the effective direction of said directional antenna, and an amplitude responsive receiver for determining the bearing of a point relative to said beacon by comparing the amplitudes of waves alternately transmitted by said antennas.

4. A radio system comprising, in combination, a beacon including a nondirectional antenna, a directional antenna having a cardioid radiation pattern, a radio wave generator, means for alternately coupling the output of said generator to said antennas, and means to continuously and progressively rotate the effective orientation of said radiation pattern, and means for determining the bearing of a point comprising a receiver at said point for comparing the intensities of waves alternately transmitted by said antennas.

5. A radio beacon comprising a nondirectional antenna, a directional antenna having a cardioid radiation pattern, a radio wave generator, means for alternately coupling the output of said generator to said antennas, means to continuously and progressively rotate the effective orientation

of said radiation pattern, and means synchronized with said antenna rotation to impart a distinctive signal to said radio wave for each effective direction of said radiation pattern.

6. A radio beacon comprising a nondirectional antenna, a directional antenna having a cardioid radiation pattern, a radio wave generator, means for alternately coupling the output of said generator to said antennas, means to continuously and progressively rotate the effective orientation of said radiation pattern, and means synchronized with said rotation to impart a distinctive code signal to said radio wave for each effective orientation of said radiation pattern.

7. A radio beacon comprising a nondirectional antenna, a directional antenna having a cardioid radiation pattern, a radio wave generator, means for alternately coupling the output of said generator to said antennas, means to continuously and progressively rotate the effective orientation of said radiation pattern, and means synchronized with said antenna rotation to impart a distinctive signal to said radio wave at at least one orientation of said radiation pattern.

8. A radio beacon comprising a nondirectional antenna, a directional antenna having a cardioid radiation pattern, a radio wave generator, means for alternately coupling the output of said generator to said antennas, means to continuously and progressively rotate the effective orientation of said radiation pattern, and means synchronized with said rotation to impart a distinctive code signal to said radio wave at at least one orientation of said radiation pattern.

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