

June 2, 1942.

R. J. KEMP

2,284,873

NAVIGATION AIDING RADIO BEACON SYSTEM

Filed April 19, 1940

2 Sheets-Sheet 1

FIG. 1.

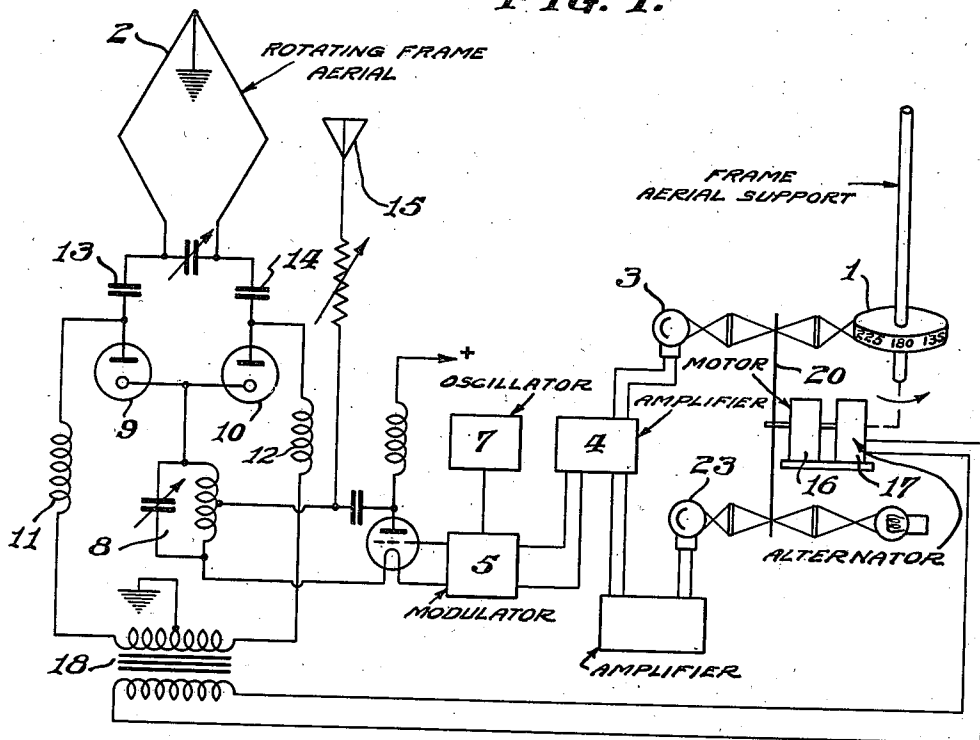
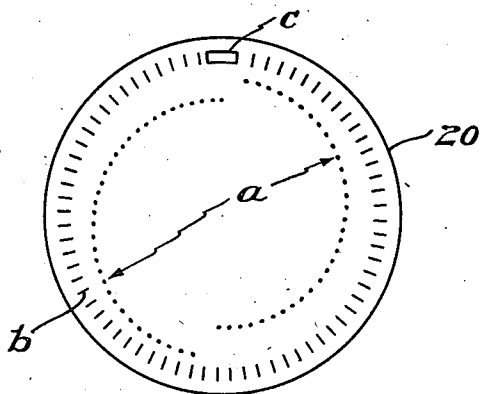


FIG. 2.



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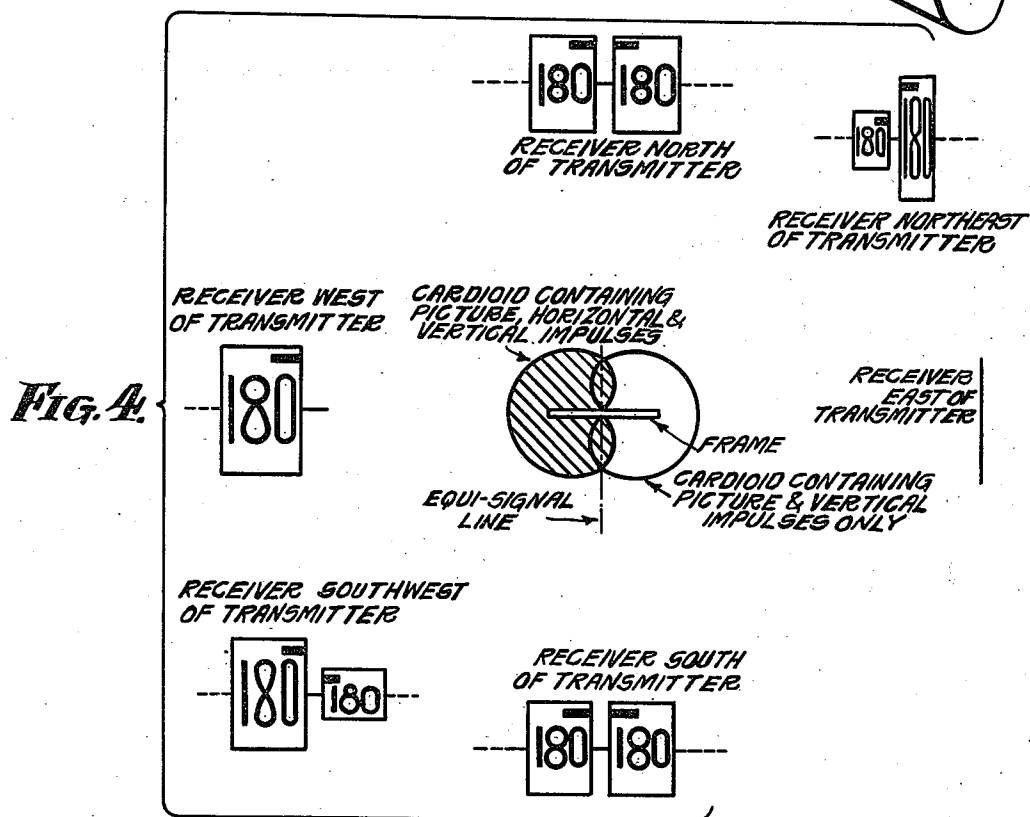
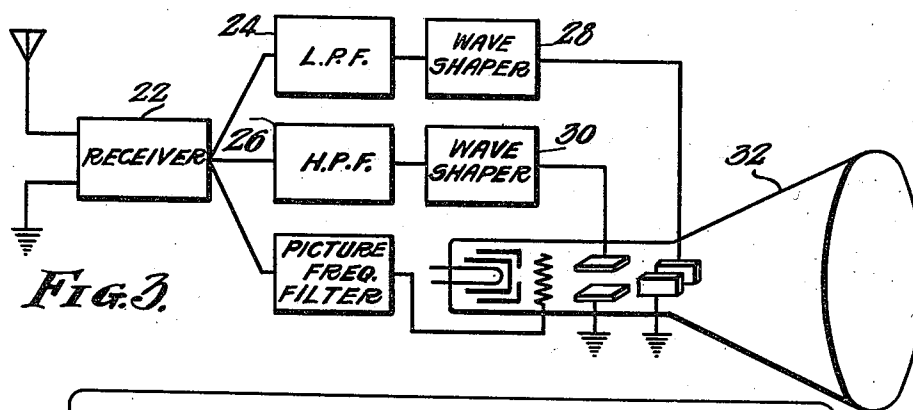
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NAVIGATION AIDING RADIO BEACON SYSTEM

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2 Sheets-Sheet 2



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NAVIGATION AIDING RADIO BEACON
SYSTEM

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10 Claims. (Cl. 250—11)

This invention relates to navigation aiding radio systems and more particularly to such systems of the television type, i. e. of the type wherein information as to the bearing of a transmitter with reference to a receiver is obtained by a co-operating receiver in the form of a television picture.

The object of the present invention is to provide improved navigation aiding radio beacon systems of the television type wherein the bearing discrimination shall be of a high order and wherein the liability to disturbance by interference shall be small. The invention is applicable both to transmitters and receivers.

According to this invention as applied to transmitters a navigation aiding radio beacon transmitter installation of the television type comprises means for radiating alternately and periodically two radiations representable by similar but oppositely disposed intersecting polar diagrams which together produce an equi-signal zone along the line of intersection, the rate of alternation of said diagrams being above the rate of persistence of vision, means for rotating the alternated diagrams about the transmitter, means for modulating the radiation corresponding to each diagram with picture signals corresponding to a scanned picture indicative of the momentary direction of the equi-signal zone, means for also modulating said radiation with scanning line synchronizing impulses and means for also modulating said radiation with a framing synchronising signal for each alternate picture-modulated diagram, i. e. so that a framing synchronising signal is included with the signals sent out on one but not on the other, of the two diagrams. At a co-operating receiver the received television signals are translated into reproduced pictures in any convenient way known per se, and line synchronisation is obtained by means such that the length of the "sweep" in the line direction is dependent upon the strength of the received line synchronising signals.

One way of carrying out this invention is illustrated in the accompanying drawings in which Fig. 1 is a circuit diagram of an embodiment of this invention, Fig. 2 is a scanning disc, Fig. 3 is the schematic diagram of a receiver and Fig. 4 illustrates received pictures corresponding to various bearings.

Referring to Fig. 1 there is provided at the transmitting installation an aerial system consisting of a frame aerial 2, and an omni-directional aerial 15—an open aerial—which jointly produce a cardioid polar radiation dia-

gram in accordance with well known principle. An electric motor 16, or the like, continuously rotates the frame aerial at a predetermined speed the connection being represented by the dotted line. (For convenience of representation, the frame aerial is shown separated from the shaft on which it is mounted.)

Rotated synchronously with the frame aerial is a compass card 1 or other device indicative of the momentary orientation of said frame aerial. A small portion of this compass card, or other device, is continuously scanned by means to be described hereinafter to produce picture signals which together with synchronising signals (obtained as will hereinafter be described) are applied to any suitable modulated carrier wave transmitter to produce a modulated carrier wave output. This output is fed to the two aerials and the relative sense of coupling of these aerials with respect to the transmitter is periodically reversed at a rate above the persistence of vision. For example, the ends of the frame aerial (between which is connected a tuning condenser as in the ordinary way) may be connected through blocking condensers 13, 14, to the anode of two diodes 9, 10, one to each, the cathodes of said diodes being connected together and to one end of a carrier frequency circuit 8 constituting the modulated carrier wave output circuit of the transmitter proper. The open aerial is connected, for example, through an adjustable resistance, to the same tuned circuit, e. g. to an intermediate tap thereon, and the diodes are made alternately conductive, whereby first one sense of relative coupling will be obtained and then the other. Accordingly with this arrangement the diodes are made alternatively conducting, two similar but opposite intersecting cardioids being thus obtained, the line of intersection being of an equi-signal line. The required alternate "switching" of the two diodes is obtained by means of an alternating potential applied thereto.

In the specific embodiment now being described, the diode anodes are connected, each through its own choke 11, 12, to the opposite ends of the centre-tapped secondary of a transformer 18, to the primary of which alternating potential is applied, the centre tap being earthed. Scanning of the television picture constituted by a small sector of the compass card is obtained by means of a scanning disc 20, see also Figure 2, having two spiral half turns being oppositely displaced with respect to a diameter of the disc and the inner end of one half turn being on the same end of the diameter as the outer end of the

other. In addition the scanning disc has a ring of line synchronising apertures or slots *b* one for each aperture in the spiral half turns, and, in the same ring with the synchronising slots, a single elongated or enlarged frame synchronising aperture *c* positioned adjacent one end of the diameter which divides the spiral half turns.

The disc is rotated by the electric motor 16 and light from the selected (changing) portion of the compass card passes through the scanning apertures *a* on one side of the centre of the disc to a photo-electric cell 3 whose output is, after suitable amplification in the amplifier represented in block diagram at 4, employed to modulate the carrier wave transmitter. The modulator and local oscillator are represented in block diagram respectively at 5 and 7. Light from a constant source is also passed through the synchronizing apertures *b* of the disc on the opposite side of the centre thereof to a second photo-electric cell 23, whose output is mixed at 4 with that from the cell already referred to.

The electric motor also drives or incorporates an alternator 17 whose output is applied to the primary of the transformer already mentioned, this alternator producing one sine wave per revolution of the scanning disc. Accordingly, due to the alternate conductivity of the diodes, 180° phase reversal of the frame aerial E. M. F. will be obtained at every half cycle of the "switching" or generator frequency.

As will be seen, in every half revolution of the scanning disc 20 the television picture will be scanned and line synchronizing signals (due to the line synchronizing slots *b* in the disc) will be obtained, the picture signals and the line synchronizing signals being transmitted from the two aeriels. Since, however, there is only one enlarged or framing synchronising slot there will only be one framing synchronizing signal for each two successive pictures. As will be obvious the two successive pictures are sent one by the radiation representable by one cardioid diagram and the other by the radiation representable by the other.

A typical receiver is illustrated in Fig. 3. Such a receiver has an ordinary cathode ray tube television receiver, and if the synchronizing signals as received are selected by suitable filters 24, 26, amplified, and applied to non-oscillating saw-tooth wave shapers, or cathode ray deflecting generators 28, 30 in such manner that the amplitude of the synchronising pulses directly determines the length of the line "sweeps," when the receiving station is on the equi-signal line the two television pictures alternately transmitted will be exactly similar to one another and will appear side by side on the screen of the cathode ray tube 32. However, when the receiver is not on the equi-signal line the two pictures will not be of the same size nor of the same shape, for one will be either taller or shorter than the other, depending upon the position of the receiving station with reference to the equi-signal line. Accordingly the bearing indicated by the received television pictures when said pictures are alike as to size and shape, will depend on the relative bearing of the transmitter and receiver. A wave shaper of the type required might include a condenser connected so as to be rapidly charged by the synchronizing impulse applied through a rectifier, and slowly discharged by a resistor. The maximum voltage across the condenser for each cycle would therefore be proportional to the amplitude of the applied impulse, and a saw

tooth scanning voltage would be produced, as required. Such a circuit is to be found in a Kreuzer Patent No. 1,999,700, filed May 25, 1931, and issued April 30, 1935.

Assume, for example, that the transmitting frame and the associated compass card are so adjusted that at the instant the frame is in an east-west plane with a given face toward the north the portion of the card 1 being televised reads 180°. At this instant a receiver located due north of the transmitter would receive two equal images of the number 180, as illustrated in Fig. 4. At the same instant a receiver located at a point northeast of the transmitter would receive two narrow pictures of unequal height. Since the line synchronising pulses driving the vertical saw tooth wave shaper or generator 30 at the receiver, are contained in both cardioids, the relative heights of the pictures will have changed in proportion to the relative cardioid amplitude. Also because only one cardioid contains a framing pulse driving the horizontal saw tooth wave shaper or generator 28 the width of the pictures will have diminished in proportion to the amplitude of that one cardioid. Still at the same instant, a receiver due east of the transmitter would produce only a vertical line, as illustrated, because in this direction the field modulated with horizontal scanning impulses is zero. At the same instant a receiver due south is again on the equi-signal line and two equal or "balanced" pictures appear. The southwest position is similar to the northeast except that horizontal scanning now predominates and wide pictures are produced. Still at the same instant, a receiver west of the transmitter would receive but a single picture since only the cardioid is received which has both horizontal and vertical impulses.

Considering now the nature of the picture at a given receiver at successive time intervals as the loop is rotated, it will be appreciated that the pictures on the screen will continuously change. In the first place, their relative size and shape will change progressively through the stages pointed out above, since the result is the same whether one considers the reception at various points about a fixed loop, or the reception at a fixed point as the loop is rotated. In the second place, the numbers appearing on the screen will also change from 0 to 360° as the loop and the compass card rotate. Thus when the receiver is due north of the transmitter, the two figures will be equal or "balanced" when a "0" appears and when a "180" appears. When the receiver is northeast of the transmitter, the figures will be equal when the numbers 45 and 225 appear, and so forth.

It will be seen that an automatic indication of "sense" is given. One can adopt the convention, for example, that a "balance" following the single picture is the true bearing and a balance following the vertical line is the reciprocal bearing. The accuracy to which the bearing can be determined is enhanced by the fact that the ratios of the letter or number sizes in the picture are distorted during the unbalance periods. It may be advantageous to include in the picture televised a horizontal line A, Fig. 4, which should serve as a balance "pointer" since the line will be reproduced in both pictures giving two similar lines which are co-linear at "balance" only.

The transmitter above described is capable of considerable modification in detail without departing from the invention; for example electron

cameras or so-called iconoscopes may be used for picture transmission in place of mechanical scanning systems such as that described, and other information—e. g. identification symbols of the transmitting station—may be included in the televised picture transmitted. Again, instead of two pictures being transmitted for each revolution of the disc 20, matters may be so arranged that only one picture is transmitted, the resultant received picture being divided into two, the two halves of the single picture bearing the same relationship to each other as do the two pictures in the several diagrams of Figure 3. This modification involves, principally, the rearrangement of apertures *a* into one spiral instead of into two half-spirals.

As previously stated the invention is applicable to directional receivers as well as to directional transmitters and may be applied to provide a direction finding receiver of the television type adapted to cooperate with an omni-directional radio beacon modified by the addition of a picture modulation for the purpose of identification. Such a receiver would be, in effect, the analogue of the transmitter hereinbefore described. In one such construction the receiver, like the transmitter above described, obtains its directional effect by employing the same principle of periodically alternating between two diagrams which intersect to define an equi-signal zone, e. g. it may incorporate aerials and an associated diode switching circuit whereby similar but opposite intersecting cardioids are alternately obtained. Again, as in the transmitter case, bearing indication is given by comparing and balancing two side-by-side patterns produced on the screen of a cathode ray tube. These patterns are formed by saw-tooth wave generators of the non-oscillating type controlled by the amplitudes of the synchronising pulses as received from the cooperating transmitter. The control grid of the cathode ray tube is operated by the picture signals. The low frequency saw-tooth generator is made to sweep at half the transmitted frequency, e. g. for a transmitted "frame" frequency of 20 R. P. S. a scan frequency of 10 R. P. S. would be used. The oscillator providing the switching frequency also provides the scan frequency and is preferably a multivibrator which can be readily controlled at its natural frequency of 10 R. P. S. (for example) by a synchronising signal of 20 R. P. S. Alternatively, of course, one frame synchronising signal could be transmitted for every two pictures.

I claim as my invention:

1. A navigation aiding radio beacon transmitter installation of the television type comprising means for radiating alternately and periodically two radiations representable by similar but oppositely disposed intersecting polar diagrams which together produce an equi-signal zone along the line of intersection, the rate of alternation of said diagrams being above the rate of persistence of vision, means for rotating the alternated diagrams about the transmitter, picture modulating means for modulating the radiations corresponding to both diagrams with picture signals corresponding to a scanned picture indicative of the momentary direction of the equi-signal zone, means for also modulating said radiations with scanning line synchronising impulses and means for also modulating the radiation corresponding to one of said diagrams with a framing synchronising signal so that a framing synchronising

signal is included with the signals sent out on one but not on the other of the two diagrams.

2. A transmitter installation as claimed in claim 1 wherein said means for radiating oppositely disposed intersecting polar diagrams comprises a frame aerial and an omni-directional aerial for producing cardioid polar diagrams modulated with picture signals corresponding to a complete picture indicative of said momentary direction.

3. A transmitting installation as claimed in claim 1 wherein said picture modulating means includes a scanning disc having two spiral half-turns of scanning apertures the spiral half turns being oppositely displaced with respect to a diameter of the disc and the inner end of one half turn being on the same end of the diameter as the outer end of the other, a ring of line synchronising apertures or slots one for each aperture in the spiral half turns, and, in the same ring with the synchronising slots, a single elongated or enlarged frame synchronising aperture positioned adjacent one end of the diameter which divides the spiral half turns.

4. A transmitting installation as claimed in claim 1 wherein said picture modulating means includes a scanning disc having two spiral half turns of scanning apertures, the spiral half turns being oppositely displaced with respect to a diameter of the disc and the inner end of one half turn being on the same end of the diameter as the outer end of the other, a ring of line synchronising apertures or slots one for each aperture in the spiral, and, in the same ring with the synchronising slots, a single elongated or enlarged frame synchronising aperture positioned adjacent said diameter.

5. A navigation aiding radio beacon transmitter installation of the television type comprising means for radiating alternately and periodically two radiations representable by similar but oppositely disposed intersecting polar diagrams which together produce an equi-signal zone along the line of intersection, the rate of alternation of said diagrams being above the rate of persistence of vision, means for rotating the alternated diagrams about the transmitter, picture modulating means for modulating the radiations corresponding to both diagrams with picture signals corresponding to one half of a picture indicative of the momentary direction of the equi-signal zone, means for also modulating said radiations with scanning line synchronising impulses and means for also modulating the radiation corresponding to one of said diagrams with a framing synchronising signal so that a framing synchronising signal is included with the signals sent out on one but not on the other of the two diagrams.

6. A transmitter installation as claimed in claim 1 wherein said picture modulating means includes a compass card rotatable with said frame aerial, and means for scanning a portion of said compass card to produce modulating signals so that the line of intersection of said oppositely disposed diagrams rotates continuously and synchronously with said compass card.

7. A navigation aiding radio system comprising in combination means for radiating alternately different directional radiations modulated by visual bearing indications and by synchronizing impulses, means for receiving said radiations, means for separately reconstituting pictures corresponding to and bearing indications from said two radiations, said visual means for varying the relative size of said pictures corresponding to

said different directional radiations in accordance with the intensity of said different directional radiations, respectively.

8. A device of the character described in claim 7 in which said means for reconstituting pictures corresponding to said visual bearing indications includes a cathode ray tube having ray deflecting means, means for deriving separate line and frame synchronizing impulses from said signal, and means for applying said derived synchronizing impulses to said deflecting means.

9. A device of the character described in claim 7 in which said means for reconstituting pictures corresponding to said visual bearing indication includes a cathode ray tube having ray deflecting means, means for deriving separate line and frame synchronizing impulses from said signal, means for producing saw tooth line drawing and framing voltages corresponding in amplitude to the amplitude of said line and frame synchroniz-

ing impulses, respectively, and means for applying said voltages to said deflecting means.

10. A navigation aiding radio system of the type wherein information in the form of a television picture is obtained of the bearing of a transmitter with respect to a receiver comprising in combination means for radiating a rotating beacon signal representable by oppositely disposed intersecting polar diagrams which together produce an equi-signal zone along the line of intersection, means for modulating said signal with television pictures indicative of the momentary direction of said beacon, means for receiving said signal, means responsive to said modulations for producing two visual pictures the dimensions of which at any instant are determined by the amplitudes of said intersecting polar diagrams, whereby balanced pictures are produced by a receiver located on said equi-signal zone.

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