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L. E. NORTON

2,364,748

RADIO RANGE

Filed April 1, 1942

FIG. 1.

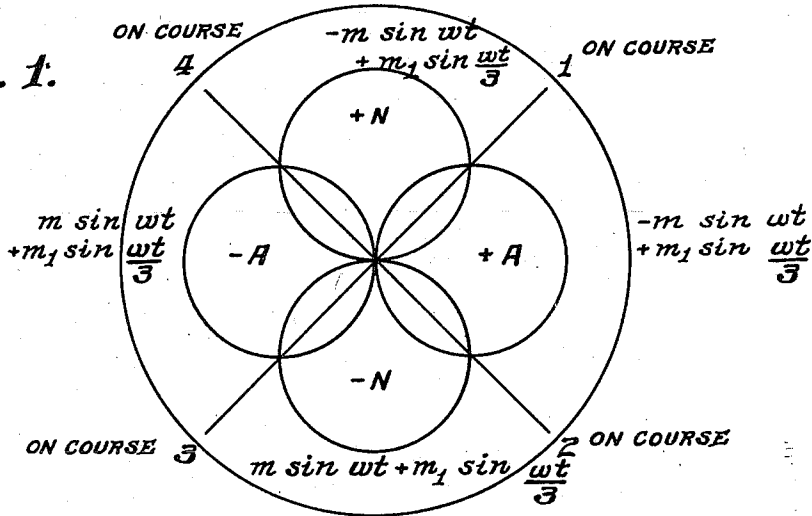


FIG. 2a.

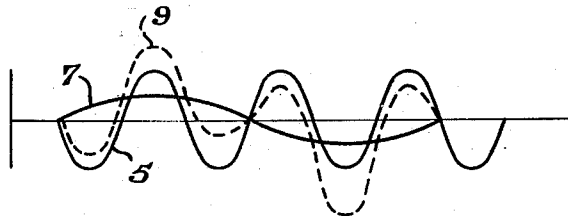


FIG. 2b.

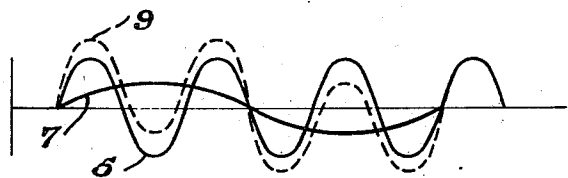


FIG. 2c.

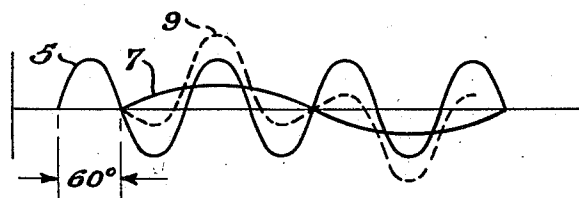
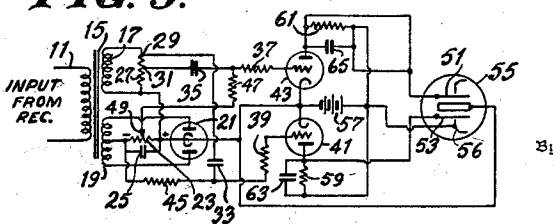


FIG. 3.



Inventor
Lowell E. Norton
C.D. Puska

Attorney

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RADIO RANGE

Lowell E. Norton, Collingswood, N. J., assignor to
Radio Corporation of America, a corporation
of Delaware

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2 Claims. (Cl. 250—11)

This invention relates to radio ranges, and more particularly to course and quadrant identification in a four course simultaneous range. In U. S. Patent No. 2,314,795 granted to D. G. C. Luck on March 23, 1943, and entitled Radio ranges, systems of quadrant identification by means of phase reference modulation are described. Application Serial No. 436,430, filed by D. G. C. Luck on March 27, 1942, and entitled Improvement in radio ranges describes a reference tone generator providing a tone definitely related in phase to the course tone but at an odd integral harmonic or subharmonic frequency. An object of the present invention is the provision of means for identifying the courses and quadrants of a radio range which radiates non-directionally a special reference tone in conjunction with the usual directional fields including interlocked A—N signals. Another object of the invention is the provision of a device for connection to the tone output of a mobile range receiver which will give a direct visual quadrant identification. A further object is the provision of a method of identifying the courses and quadrants of a four-course radio range.

The invention will be described with reference to the accompanying drawing, of which Fig. 1 is a graph of a radio range pattern; Fig. 2A is a graph representing the voltages appearing in the output of a receiver operating in a positive range lobe, Fig. 2B is a similar representation of the voltages produced in a negative range lobe, Fig. 2C represents the voltages of Fig. 2B after one component has been acted upon by a phase shifter; and Fig. 3 is a circuit diagram of the device of the invention.

Referring to Fig. 1, the equisignal courses 1, 2, 3 and 4 are indicated as the lines along which a receiver will pick up signals A and N with equal intensity from the range transmitter. The directive radiation patterns of the range antennas are illustrated as overlapping figures of eight with lobes of opposite polarities, arbitrarily designated as positive and negative. In the usual four course simultaneous range, a non-directional antenna is used to radiate a carrier which may be modulated with speech, or in the present instance, with a reference tone. The side bands, modulated at 1020 cycles per second, the so-called course tone, are directionally radiated by the range antennas and are keyed by interlocking signals A (—) and N (---) respectively as indicated in Fig. 1. As described in the aforementioned application Serial No. 272,017, the non-directional carrier may be modulated with a ref-

erence tone related in phase and frequency to the course tone for providing an indication to the operator of a receiving station of the course or quadrant in which the receiving station is located.

With a range set up for a reference tone of one-third the frequency of the course tone, the transmitter phases may be adjusted so that a course tone peak occurs simultaneously with a reference tone peak in the pattern lobes marked plus, while a course tone trough coincides with a reference tone peak in the lobes marked minus in Fig. 1. These relationships are illustrated in Figs. 2a, 2b and 2c, where the course tone voltage is represented by the curve 5 and the reference tone voltage by the curve 7. Fig. 2a shows the voltages appearing in the output of a receiver in one of the positive lobes, while Fig. 2b shows the voltages in the output of a receiver in one of the negative lobes. It is apparent that the ratio of the peaks to the average value of the resultant wave 9 is considerably higher in the positive quadrants than it is in the negative quadrants. In accordance with the invention, an indicator is actuated as a function of the ratio of the peak value to the average value of the complex range modulation.

Referring to Fig. 3 the output of a range receiver (not shown) is supplied to the primary 11 of a transformer 15, which is provided with two secondary windings 17 and 19. The secondary 17 is connected to a voltage divider 27 provided with taps 29 and 31. The tap 29 is connected through a capacitor 33 and a current limiting resistor 39 to the grid of a vacuum tube 41. The capacity of the capacitor 33 is so related to the resistance of the grid leak 45 that substantially no phase shift at the reference tone frequency is produced by the combination. The tap 31 of the voltage divider 27 is connected through a capacitor 35 and a current limiting resistor 37 to the grid of a second vacuum tube 43. The capacity of the capacitor 35 is so related to the resistance of the grid leak 47 that a phase shift of approximately 60° is introduced in the reference tone wave with respect to its unshifted phase, or with respect to a fixed reference such as the course tone wave.

The secondary 19 of the transformer 15 is connected to a double diode tube 21 in a full wave rectifier circuit. The output of the rectifier 21 is delivered across a tapped resistor 23, which is connected to supply predetermined fractions of the rectified voltage to the grids of the tubes 41 and 43 in series with the voltages applied thereto from the secondary winding 17.

The anodes of the tubes 41 and 43 are connected to the control electrodes 53 and 51 respectively of a twin electron ray indicator tube 55 such as an RCA 6AF6-G. Anode potential is supplied to the tubes 41 and 43 from a source 57 through the load resistors 59 and 61 respectively, shunted by capacitors 63 and 65. The target potential for the indicator tube 55 is also provided by the source 57.

The operation of the device is as follows: The complex wave corresponding to the combined modulations of the range is rectified at 21 to produce a direct voltage proportional to the average value of the wave which may or may not be keyed, depending on whether the receiver is in an "A," "N," or "on course" position. A sufficient fraction of this voltage is applied to the grids of the tubes 41 and 43 through the resistors 39 and 47 as to bias the tubes beyond cut off to such an extent that a wave of the form shown in Fig. 2b will not have peaks sufficiently high to overcome the bias and allow either tube to conduct plate current. However, the circuit adjustment must be such that the peaks of a wave like that shown in Fig. 2a which has peaks higher than any part of that shown in Fig. 2b will overcome the bias and allow short pulses of plate current to flow. The function of the phase shifting network 35, 47 is to change the relationship between the two modulation components as shown in Fig. 2c, which represents the resultant of a wave like that of Fig. 2b after it has been acted upon by the phase shifter. Comparison with Fig. 2a shows the shapes to be nearly the same. Thus the phase shifter changes a wave derived from the signal in a quadrant of one polarity to a wave having the shape of one derived from the signal in a quadrant of the opposite polarity. If the device is operating in a positive quadrant, the ratio of peak to average value of the modulation will be relatively high, and the bias of the tube 41 will be overcome enough to allow short pulses of plate current to flow. These pulses are smoothed into a substantially constant voltage by the integration circuits including resistor 59, capacitor 63, and resistor 61 and capacitor 65, keyed according to the quadrant keying of the course tone. The electrode 53 of the indicator tube is energized by this voltage, causing the corresponding section of the fluorescent target to "blink" with the keying. Since the voltage applied to the grid of the tube 43 is acted upon by the phase shifter 35, 47, it has a relatively low ratio of peak to average value, and the tube 43 remains cut off. Conversely, in a negative quadrant, the section of the target 56 controlled by the electrode 51 will "blink" with the course tone keying, while the section controlled by the electrode 53 will not. The indicator will be actuated in a similar manner when the receiver is on one of the courses defined by the overlapping lobes,

along course 1, the positive section of the indicator will be continuously actuated; along course 2 the positive section will "blink" A and the negative section will "blink" N, and so on.

Thus the invention has been described as a device for connection to the output of a mobile range receiver to give visual identification of the courses and quadrants of a four course simultaneous radio range which non-directionally radiates an auxiliary reference modulation. This is done by comparing the peak and average values of the resultant modulation, and actuating indicators in accordance with their ratio.

I claim as my invention:

1. In a course and quadrant identification system for a four course simultaneous radio range, arranged to radiate directionally fields of one side band frequency and to radiate non-directionally a field modulated at a frequency harmonically related to the modulation frequency corresponding to said side band, means for deriving from the resultant range signal an alternating current wave corresponding to the modulation of said range signal, rectifier means arranged to derive from said wave a potential proportional to the average amplitude thereof, two amplifiers connected to said rectifier means and biased beyond cut-off by said potential, means connected to apply said alternating current wave directly to the input of one of said amplifiers and through a phase-shifting network to the input of the other of said amplifiers, whereby one of said amplifiers operates when the ratio of the peak amplitude to the average amplitude of said alternating current wave exceeds a predetermined value, and the other of said amplifiers operates when said ratio is less than a predetermined value, and indicator means connected to the respective output circuits of said amplifiers.

2. A device responsive to the ratio of the peak amplitude to the average amplitude of a complex wave comprising two harmonically related components, including means for deriving from said wave a first potential proportional to the average amplitude thereof, means for deriving from said wave a second potential proportional to the peak amplitude thereof, means arranged to add said second potential to said first potential and apply the sum to the control circuit of a first peak responsive device, means arranged to shift the phase of the lower frequency one of the harmonically related components of said complex wave with respect to the higher frequency component of said wave and to derive from the resultant wave a third potential proportional to the peak amplitude thereof, means arranged to add said third potential to said first potential and apply the sum to the control circuit of a second peak responsive device.

LOWELL E. NORTON.