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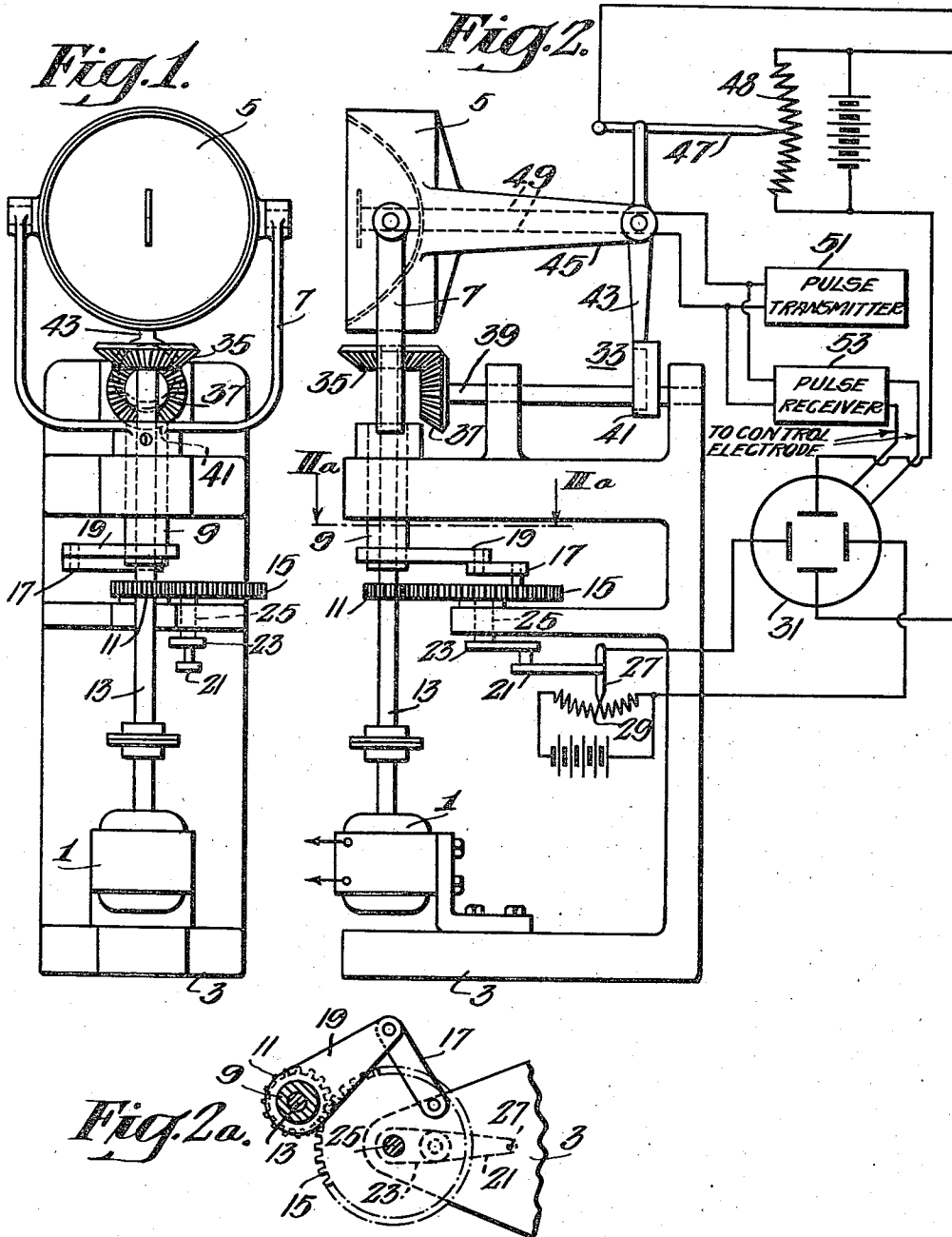
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ORIENTING MECHANISM FOR PULSE ECHO SYSTEMS

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3 Sheets-Sheet 1



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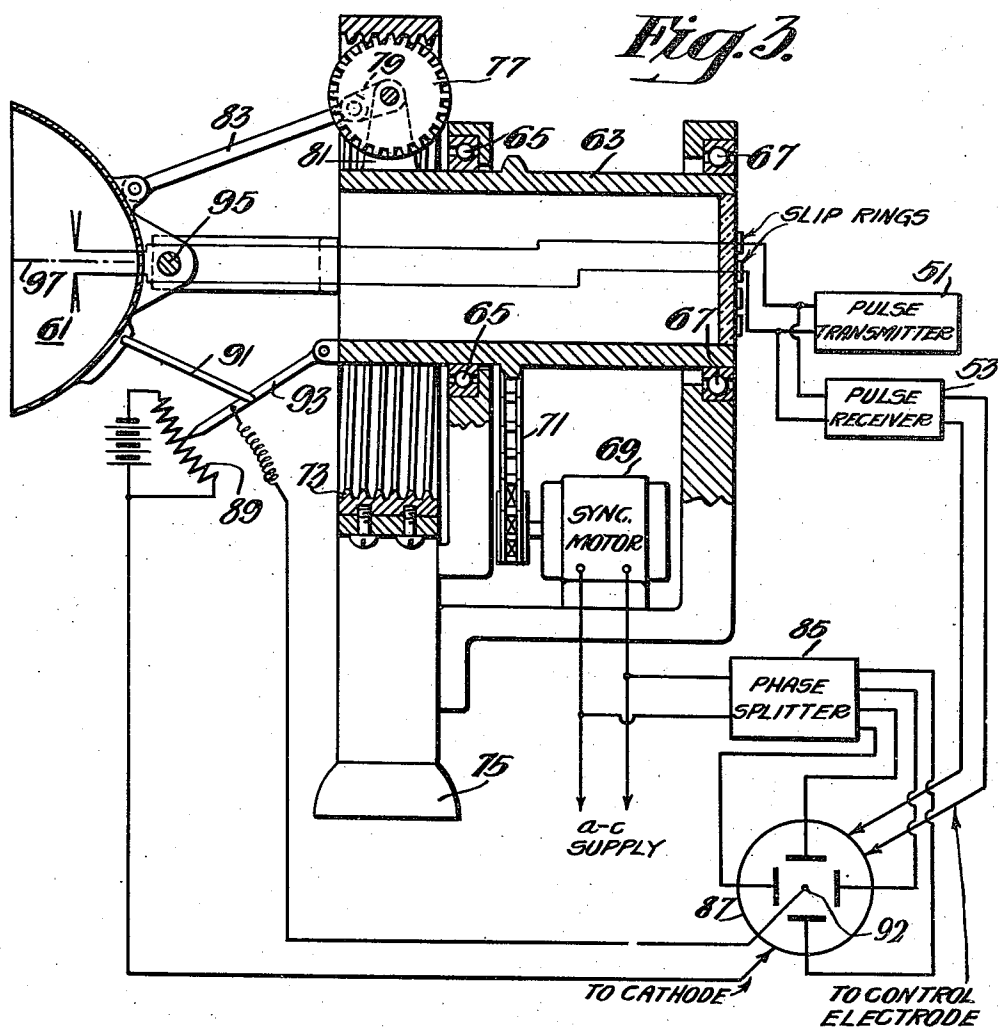
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ORIENTING MECHANISM FOR PULSE ECHO SYSTEMS

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3 Claims. (Cl. 250-11)

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This invention relates to scanning devices and particularly to improvements in devices for varying the direction of a beam of energy from a pulse echo system and for directing in synchronism therewith the scanning beam of a cathode ray indicator.

Pulse echo systems are used to detect objects and to indicate the direction and distance of the object. In such systems a directive antenna is generally used for the pulse transmission and a non-directive antenna may serve for reception or vice versa, or directive antennas may be used for both transmission and reception.

While separate antennas may be used, the instant invention is described by referring to a single directive antenna which may be used for both transmission and reception. Such an antenna system is described in the copending application Serial No. 184,354, filed January 11, 1938, by Wolff and Herschberger, for Signaling system.

One of the objects of the instant invention is to provide improved means for scanning a region by a beam of pulse energy. Another object is to provide improved means for moving a beam of pulse energy and a cathode ray beam in synchronism. Another object is to provide means for directing a beam of pulses throughout a conical region and for synchronously directing a cathode ray beam in a helical pattern.

The invention will be described by referring to the accompanying drawings in which Figures 1 and 2 are front and side views, respectively, of one embodiment of the invention; Figure 2a is a fragmentary sectional view along the line IIa-IIa; Figure 3 is a sectional view of another embodiment of the invention; Figure 4 is a schematic diagram of a modification for conical scanning; and Figure 5 is a circuit diagram of a modification of Figure 4. Similar reference characters are applied to similar elements in the several figures.

Referring to Figs. 1, 2 and 2a, a motor 1 is mounted on a base 3 which supports a directive antenna system 5. The antenna system is pivotally mounted in a yoke 7. The yoke is oscillatably mounted on a hollow bearing member 9. The oscillations of the yoke are produced by means of a driving gear 11 which is secured to a shaft 13 extending from the motor 1 through the hollow bearing member 9. The driving gear engages a driven gear 15. A pair of links 17, 19 or a cam slot or the like, connect the driven gear to the yoke so that as the gear rotates the yoke is oscillated through the desired angle. A second set of link members 21, 23 are used to

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connect the gear shaft 25 with a potentiometer arm 27 so that the potentiometer arm oscillates in synchronism with the antenna system 5. The output leads from the potentiometer 29 are connected to the horizontal deflecting electrodes of a cathode ray tube 31.

The antenna system 5 is oscillated about the yoke pivots by an eccentric 33 which is driven in the following manner: A first bevel gear 35 is connected to the motor shaft 13 and is arranged to engage a second bevel gear 37 which is mounted on a stub shaft 39. A cam 41 is secured to the shaft 39 and is arranged to engage the inside surface of an aperture in a connecting rod 43. The connecting rod 43 is pivotally connected to a member 45 which terminates in the antenna system. The eccentric 33 is also connected to a potentiometer arm 47. The potentiometer arm is arranged to oscillate in synchronism with the antenna system as it moves about its horizontal axis on the yoke. The output of the potentiometer 48 is applied to the vertical deflecting electrodes of the cathode ray tube 31.

The antenna system is connected by a transmission line 49 to a pulse transmitter 51 and to a pulse receiver 53. The output of the pulse receiver is applied to the control electrodes of the cathode ray tube 31 so that received signals may brighten or dim the cathode ray trace. The trace is moved horizontally in synchronism with the oscillations of the antenna system about its vertical axis. The trace is moved vertically in synchronism with the oscillations of the antenna system about its horizontal axis. The ratio of horizontal to vertical oscillations is determined by the several gear ratios.

The cathode ray screen may be provided with a suitable calibration so that the azimuth and elevational angles at which an echo pulse is observed may be indicated. From the nature of the antenna movements, it follows that the directive beam will explore a substantially pyramidal form. The cathode ray trace will correspond to the base of the pyramid.

In some installations it may be desirable to explore a conical region. One suitable arrangement for scanning conically is shown in Fig. 3. In this arrangement the antenna system 61 is mounted on a cylindrical member 63 which is journaled in bearings 65, 67. The antenna system is rotated by a motor 69 which may be connected by a belt, chain drive 71, gearing or the like, to the cylinder 63. A ring gear 73 is secured to the base 75 which supports a synchronous motor 69 and bearings 65, 67. A pinion gear 77,

mounted on the cylinder 63, engages the ring gear 73. A pair of cranks 79 are connected to the pinion gear shaft on either side of the bearings 81 therefor. The cranks 79 are connected by links 83 to the antenna system 61.

The synchronous motion of the cathode ray is effected by the following means: The currents applied to the synchronous motor 63 are also applied to a phase splitter 85 and hence to the cathode ray deflecting electrodes of the cathode ray tube 87 to produce a circular trace. The radius of the trace is controlled by deriving biasing voltages from a potentiometer 89 which is operated in synchronism with the radial movements of the antenna system. The potentiometer 89 is operated as follows: A link 91 is used to connect the antenna system to the potentiometer arm 93. As the antenna system moves on its pivotal mounting 95, the arm 93 will move to vary the potentiometer output voltage, which is applied to a radial deflecting electrode 92 of the cathode ray tube 87.

It should be understood that as the antenna system is rotated about the axis 97 of the cylinder 63, the gear 77 through the movements of the crank 79 and connection lever 83, slowly tilts the antenna system about its axis 95. Thus the beam of pulse energy from the antenna traverses a conical region, or expressed another way, the axis of the beam traverses a spiral path. The cathode ray also traverses a spiral path and it moves in synchronism with the beam from the antenna.

The ratio of the two movements which make up the conical scanning by means of the radio beam is determined by the ratio of the ring gear 73 to the pinion gear 77. This ratio may be selected to obtain the required definition of scanning. While the arrangement has been shown for scanning a conical region in which the axis of the cone lies between the horizon and the zenith and including a definite azimuth angle, it should be understood that by mounting the base 75 in a vertical plane the device may be used to scan throughout the azimuth as will be shown in a modification of the invention.

A modification of the foregoing arrangement is shown in Fig. 4 in which an electromechanical drive is substituted for the mechanical system of Fig. 3. In the modified arrangement the directive antenna system 101 is mounted in a ball and socket or other universal joint 103 which is supported by a post 105 extending from the base member 107. Three solenoid type motors 109 are preferably mounted at 120° intervals. The motors each include a polarized magnetic armature or movable member 111.

The movable members 111 are connected by suitable links 113 to bearings 115 on the outer portion of the antenna reflector or other antenna member. The field coils of the motors are energized by a three phase alternator 117, which is driven by a motor 119. The shaft 120 of the alternator, or the driving motor 119, is connected through suitable gearing 121 to a rheostat 123 in the generator exciter circuit 124. The generator output is thus varied according to any desired pattern so that the three phase output voltage follows, for example, a sawtooth pattern. The motors 109 are successively energized by the three phase currents so that the antenna system undergoes a circular rocking movement of an amplitude varying according to the generator output. The resulting antenna beam deflections follow a spiral pattern. That is, as the applied voltages in-

crease because of the sawtooth wave form of the generator exciting voltage, the motors 109 produce larger and larger movements and since the movements are preferably at 120° intervals in space and in time, the axis 125 of the antenna 128 traces a helical pattern and the beam of pulses from the antenna scan a conical or hemispherical region. The three phase currents may be applied to a three coil deflecting system 130 arranged around the cathode ray indicator 132 to rotate the cathode ray in synchronism with the rotations of the antenna, and the sawtooth voltages may be applied to produce radial movements. The cathode ray will trace a helical pattern on the fluorescent screen of the indicator, which may be provided with a suitable calibrated scale 134 to indicate the position of the reflecting object with respect to predetermined coordinates.

Instead of using polarized magnetic armatures in the solenoid motors 109 and applying sawtooth exciting voltages to the three phase generator, the movable motor members 111 may consist of a second solenoid 112 to which the sawtooth voltages from the potentiometer 123 may be applied, as shown in Fig. 5. Under these circumstances, the three phase currents are applied to the fixed windings and the direct currents are applied to the movable windings, or vice versa, so that the antennas will be deflected by variable amounts so that its axis follows a helical path as before. In either arrangement the connecting rods may be provided with biasing springs 125 to maintain the zero or central position of the antenna, which has been omitted to avoid complicating the diagram.

Thus the invention has been described as an improved means for scanning a region by means of a beam of pulses. A cathode ray is moved in synchronism with the scanning beam. Received pulse echoes are applied to modulate or vary the cathode ray so that an object will be indicated according to predetermined coordinates on the cathode ray tube screen. In this manner the sky from the horizon upwardly may be continuously scanned and reflections from an aircraft or surface vessel coming over the horizon will indicate the azimuth and elevation of the craft.

I claim as my invention:

1. A pulse echo scanning device including a directive antenna for radiating a beam of pulses and for receiving reflected pulses returning substantially along said beam, means for moving said antenna so that said beam traces a spiral in a plane normal to said beam so that said beam scans a conical region, a receiver connected to said antenna and responsive to said reflected pulses, a cathode ray indicator including ray deflecting and ray varying elements, means for deriving from said antenna movements currents corresponding to said spiral, means for applying said currents to said ray deflecting elements so that said ray is synchronously moved in a spiral path corresponding to the said beam spiral, and means for applying to said ray varying element currents deriving from said receiver and corresponding to said reflected pulses to indicate the position of a pulse reflecting object.

2. A pulse echo scanning device including, in combination, a directive antenna for radiating a beam of pulses and for receiving echo pulses from objects in said beam, a rotatable support for said antenna, means for pivotally mounting said antenna on said support, means for rotating said support, a ring gear and a pinion gear cooperat-

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ing with said rotatable support so that said pinion gear is rotated as said support is rotated, a crank member operated by said pinion gear, a link member connecting said crank and said antenna for moving said antenna back and forth on said pivotal mounting as said antenna support is rotated, the movements of said support and said antenna directing said beam of pulses in a spiral path, a receiver connected to said antenna and responsive to said echo pulses, a cathode ray indicator connected to said receiver for indicating said echo pulses, and means responsive to said antenna support and antenna movements for synchronously moving said cathode ray along a path corresponding to said spiral.

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3. A radio beam scanning device including an antenna system for establishing a sharply defined beam, a rotatable support including a pivotal mounting for said antenna system, means for rotating said support, a ring gear and a pinion gear cooperating with said rotatable support so that said pinion gear is rotated as said support is rotated, a crank member operated by said pinion gear, and a link member connecting said crank and said antenna system for moving said antenna system back and forth on said pivotal mounting as said antenna support is rotated.

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