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M. A. EDWARDS ET AL

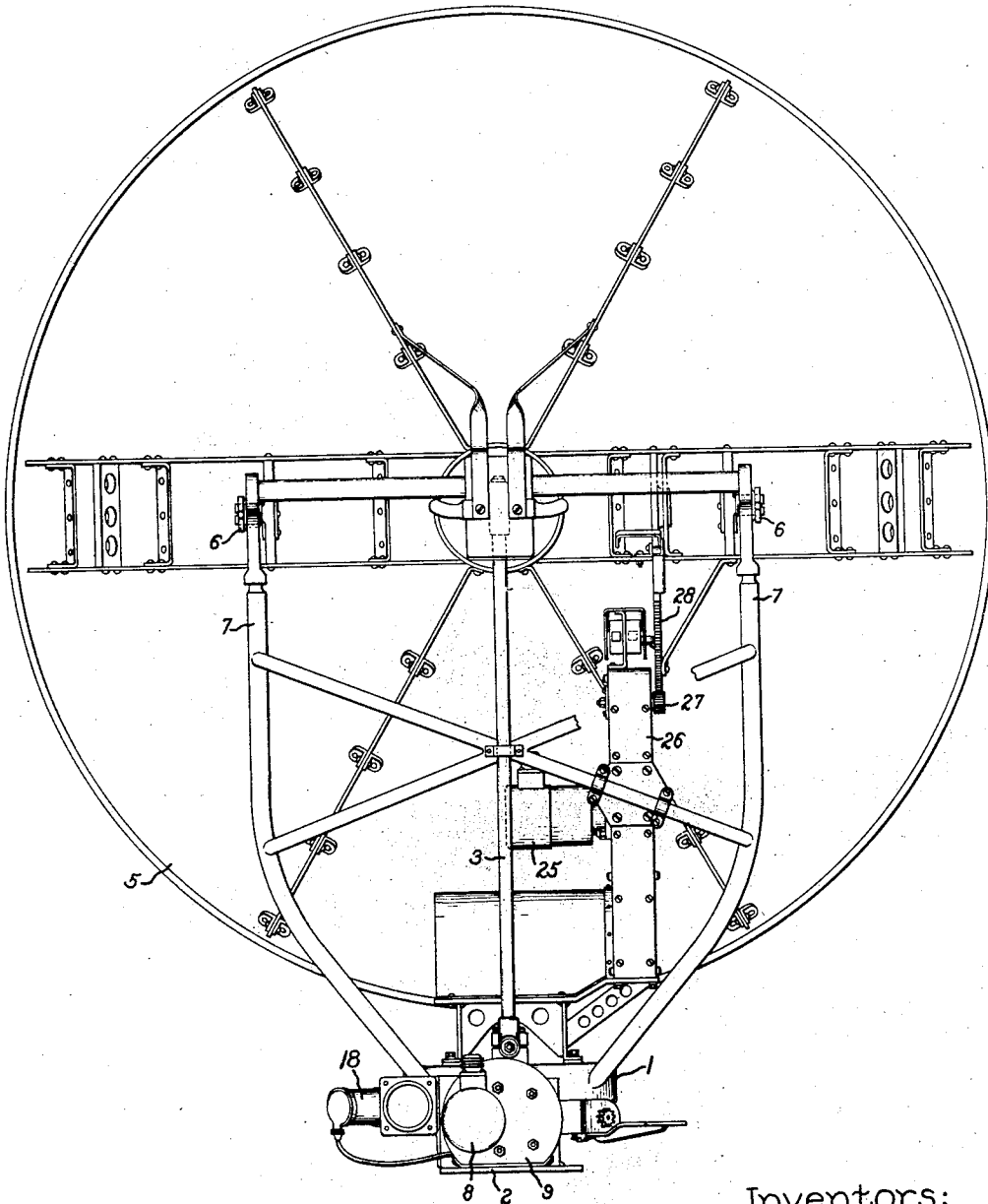
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3 Sheets-Sheet 1

Fig. 1.



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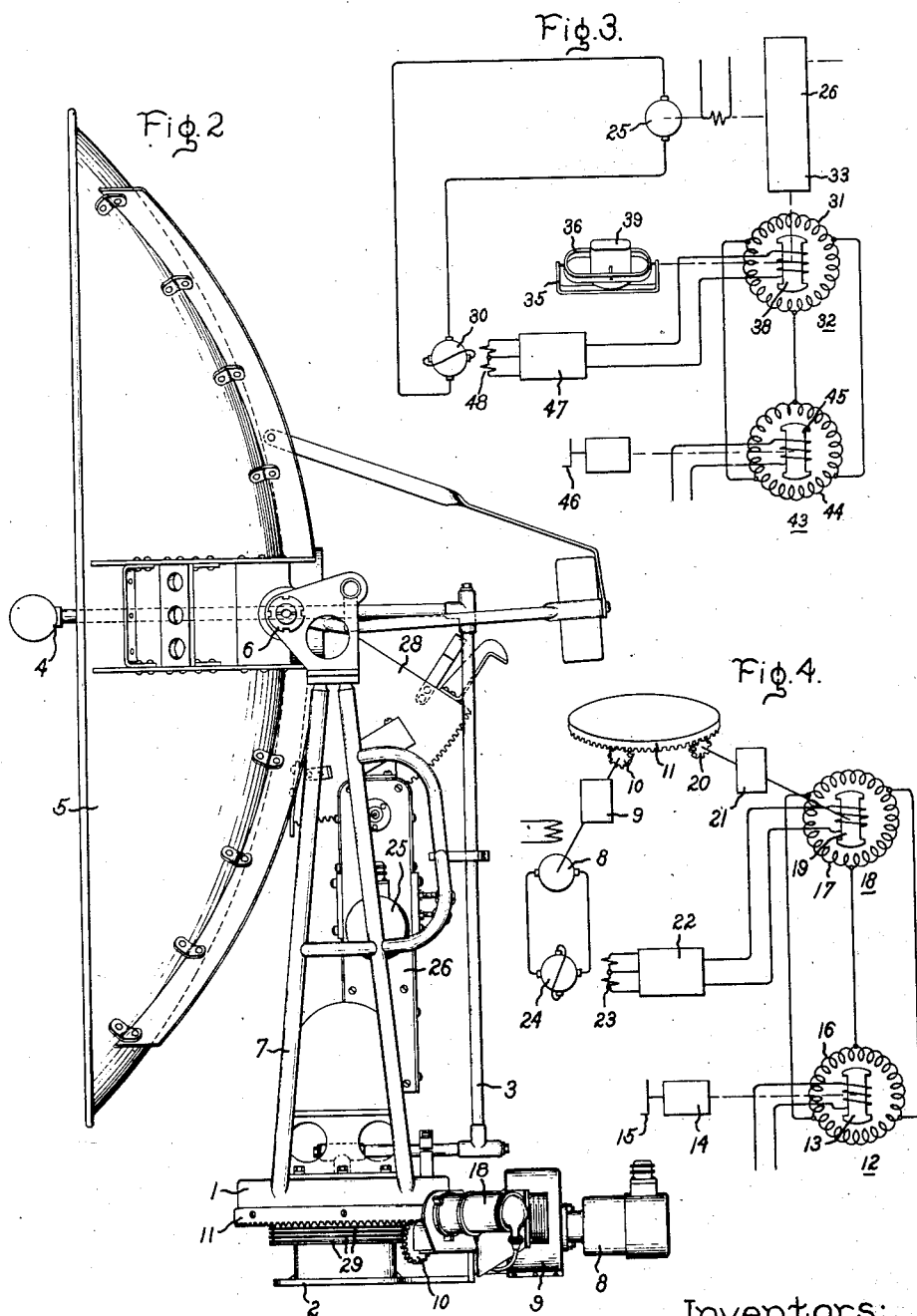
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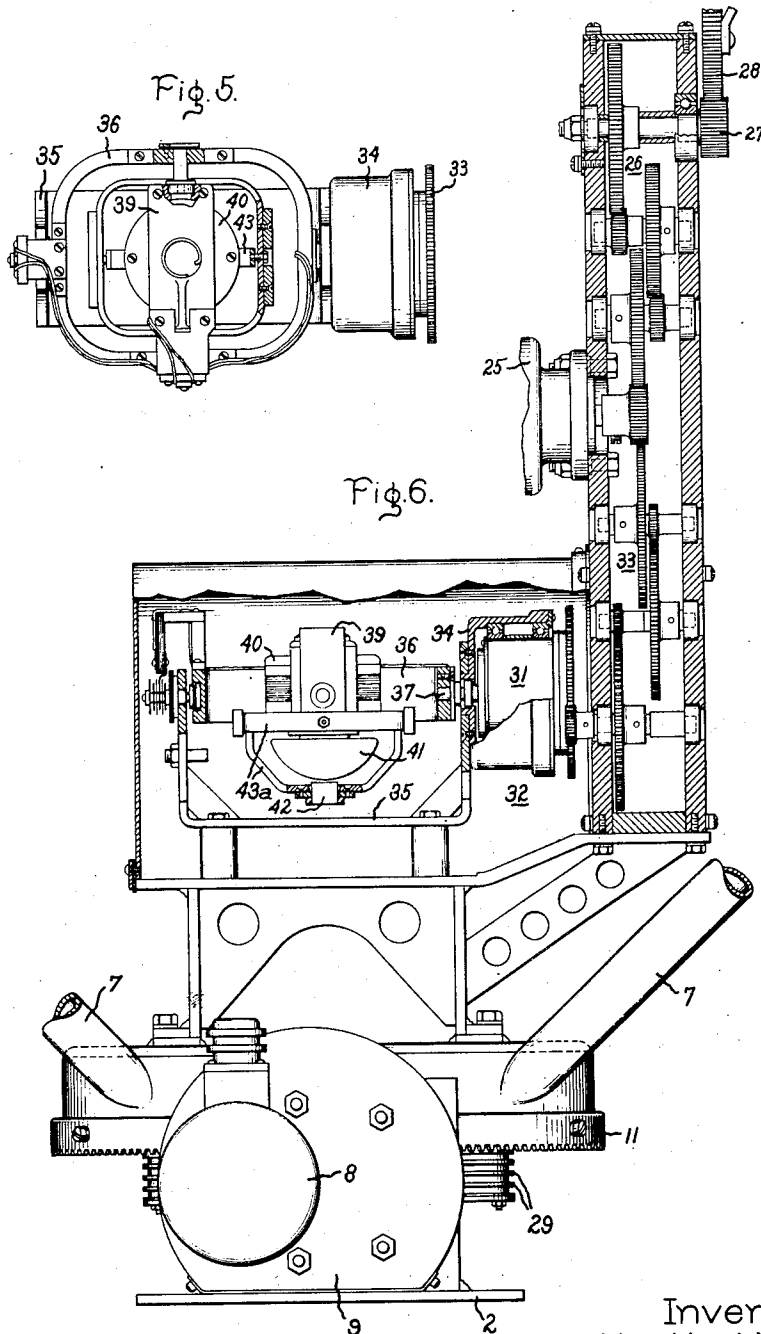
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UNITED STATES PATENT OFFICE

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ANTENNA

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The present invention relates to directional antennas of the type known as scanners or spinners, and is particularly concerned with an arrangement for preventing shifting of the directive axis of the antenna due to the pitch or roll of the support (e. g. a ship) on which the antenna is carried. Such antennas are primarily used with radio locating equipment for scanning the horizon or zones at a small elevation from the horizon to obtain information as to the location of remote objects.

The object of our invention is to provide a directive antenna with an improved arrangement for neutralizing the effect of pitch or roll.

The novel features which we believe to be characteristic of our invention are set forth with particularity in the appended claims. Our invention itself, however, both as to its organization and method of operation, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying drawings in which Fig. 1 is a rear elevation of an antenna embodying our invention; Fig. 2 is a side elevation; Fig. 3 is a diagram of the elevation control; Fig. 4 is a diagram of the azimuth control; Fig. 5 is a top plan view of the gyroscope; and Fig. 6 is a sectional elevation of the elevation drive.

Referring to the drawings, there is shown a scanner mounted on a turntable 1 journaled for rotation on a vertical axis in a base 2. Fixed on the turntable is a transmission line 3, the lower end of which is connected to a rotating joint (not shown) at the axis of the turntable and the upper end of which extends through a clearance opening in a parabolic reflector 5 and terminates in a radiator 4, shown in Fig. 2. The radiator and reflector constitute an antenna having a directive axis determined by the relative position of the radiator and reflector. The reflector is supported by trunnions 6 at the upper ends of standards 7 fixed to the turntable for tilting relative to the turntable on a horizontal axis perpendicular to the axis of the reflector. The directive axis of the antenna is shifted in azimuth by rotating the turntable and in elevation by tilting the reflector relative to the turntable. Due to reflection the directive axis is shifted in elevation through twice the angle between the radiator 4 and the axis of the reflector.

The turntable is rotated in azimuth by a motor 8 through reduction gearing 9 which drives a pinion 10 meshing with a crown gear 11 fixed to the outer edge of the turntable. The position of the

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directive axis of the antenna in azimuth, which corresponds to the position of the turntable, is controlled by a generator Selsyn 12 (which may be located in a control box remote from the antenna) having its rotor 13 connected to an A.-C. supply and optionally rotated by a motor 14 or a hand crank 15 and having its stator 16 connected to the stator 17 of a Selsyn transformer 18 on the base 2. The rotor 19 of the Selsyn transformer is driven from the crown gear 11 through a pinion 20 and reduction gearing 21 so its position at all times corresponds to the azimuth of the antenna. Whenever the position of the rotor 19 does not exactly correspond to the position of the rotor 13 of the indicator Selsyn, a displacement voltage is induced in the rotor 19 which corresponds in magnitude with the magnitude of the displacement and in phase with the direction of the displacement. In apparatus indicated at 22, the displacement voltage is converted by amplification and rectification to a D.-C. voltage varying in magnitude and polarity in accordance with the magnitude and direction of the displacement. This voltage is applied to the fields 23 of a generator 24 which generates a voltage corresponding to its excitation in magnitude and polarity. The voltage of the generator 24 is applied to the motor 8, causing rotation of the turntable in the direction to reduce the displacement between the rotors of the Selsyns 12 and 13 so that the directive axis of the antenna is positioned in azimuth in accordance with the generator Selsyn 12.

The directive axis of the antenna is shifted in elevation by a motor 25 through reduction gearing 26 having a pinion 27 meshing with a gear sector 28 fixed to the back of the reflector 5. The motor 25 is energized through slip rings 29 on the turntable from a generator 30 similar to the generator 24. The connections to the other electrical apparatus carried by the turntable are also made through the slip rings 29. The motor also drives the stator 31 of a Selsyn transformer 32 through reduction gearing 33 having one half the reduction of the gearing driving the reflector so the angular position of the stator 31 corresponds to the elevation of the directive axis of the antenna which is shifted by twice the angle the reflector is moved. The stator 31 is journaled in a housing 34 fixed to a U-shaped frame 35 bolted to the turntable. Journaled in the frame 35 on a horizontal axis perpendicular to a vertical plane including the directive axis of the antenna is a frame 36 having a shaft 37 fixed to the rotor 38 of the Selsyn transformer 32. The frame 36 is held horizontal in a plane along the directive axis of

the antenna by a gyroscope stable vertical carried in a frame 39 pivoted to the frame 36 on a horizontal axis along the directive axis of the antenna. The gyroscope consists of an induction motor having its stator fixed to the frame 39 and a rotor 40 surrounding the stator. At the lower end of the rotor is a spherical eddy current damper 41 cooperating with a permanent magnet 42 supported by a universal pendulous suspension 43a from the frame 39. The magnet, which is free to swing in any direction, has a very short period and its average position over an interval of a few seconds is true vertical. If the axis of the rotor 40 differs from true vertical, the drag due to eddy currents in the damper 41 causes the gyroscope to precess toward true vertical. So long as the gyroscope is in true vertical, the frame 36 is horizontal in a vertical plane along the directive axis of the antenna although the frame may be inclined in a perpendicular vertical plane.

The elevation of the antenna is controlled by a Selsyn 43 (which may be located in a control box remote from the antenna) having a stator 44 connected to the stator 31 of the Selsyn transformer 22 and a rotor 45 connected to an A.-C. supply. The rotor 45 is positioned to the desired elevation angle in any suitable manner, for example by a hand crank 46. Whenever the position of the rotor 38 of the Selsyn transformer does not correspond to the position of the rotor 45, a displacement voltage is induced which corresponds in magnitude to the magnitude of the displacement and in phase to the direction of the displacement. In apparatus indicated at 47, the displacement voltage is amplified and rectified and supplied to the fields 48 of the generator 30 which generates a control voltage for the motor 25 of magnitude and polarity such that the motor drives the stator 31 (and the antenna) in the direction to decrease the displacement.

In the use of the antenna, the base 2 may be fastened to a support, such as a platform on a ship, and the control box, containing the Selsyns 12 and 43, the apparatus 22 and 47, and the generators 24 and 30 may be located at some convenient point remote from the antenna. When used on a ship, the platform supporting the antenna is usually located at as great a height as possible so radio waves along the directive axis of the antenna will encounter a minimum of obstruction. Since the direction in which the antenna is pointed is indicated by the Selsyns 12 and 43, the control box is usually located at the place at which this information is used.

The operator, by the hand crank 15 or motor 14, determines the position of the directive axis of the antenna in azimuth and by the hand crank 46 determines the position of the directive axis of the antenna in elevation. Through the displacement voltages induced in the Selsyn transformers 18 and 32, the voltages are generated by generators 24 and 30 of magnitude and polarity such as to cause the motors 8 and 25 to shift the directive axis of the antenna in azimuth by rotating the turntable 1 and in elevation by tilting the reflector 5 to a position corresponding to the azimuth and elevation indicated by the positions of the hand cranks 15 and 46. As the ship pitches and rolls, the components of the pitch and roll along the directive axis of the antenna are compensated by the gyroscope 39 which holds the frame 36 horizontal in a vertical plane along the directive axis of the antenna. This holds the rotor 38 of the Selsyn transformer 32 in a horizontal position and causes the stator 31 to assume

a position relative to the rotor 38 corresponding to the relative position of the rotor 45 and the stator 44. The directive axis of the antenna, which corresponds to the position of the stator 31, is accordingly held at the elevation angle corresponding to the setting of the hand crank 46. Since the elevation of the directive axis of the antenna is with reference to the horizontal frame 36, the elevation is not affected by tilting of the base due to pitch or roll. The pitch and roll are compensated only along the directive axis of the antenna. When the directive axis is lengthwise of the ship, the compensation is solely for pitch of the ship since the roll of the ship does not affect the azimuth or elevation of the directive axis. When the directive axis is crosswise of the ship, the compensation is solely for roll since pitch does not affect the azimuth or elevation of the directive axis. At intermediate points, the compensation is solely for the components of pitch and roll along the directive axis since the components of pitch and roll at right angles to the directive axis do not affect the azimuth or elevation of the directive axis.

While we have shown particular embodiments of our invention, it will be understood that many modifications may be made without departing from the spirit thereof, and we contemplate by the appended claims to cover any such modifications as fall within the true spirit and scope of our invention.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. In combination, a directional antenna, means supporting the antenna for tilting about a horizontal axis perpendicular to its directive axis, a turntable rotatable on a vertical axis carrying said supporting means, a frame on the turntable pivoted on a horizontal axis perpendicular to a vertical plane including said directive axis, a gyroscope on said frame holding said frame horizontal in a direction along said directive axis, and means responsive to the angle between said frame and the directive axis of the antenna for rotating the antenna on its horizontal axis to maintain said angle at a predetermined value.

2. In combination, a directional antenna, means supporting the antenna for tilting about a horizontal axis perpendicular to its directive axis, a frame pivoted on a horizontal axis perpendicular to a vertical plane including said directive axis, a gyroscope on said frame holding said frame horizontal in a direction along said directive axis, a motor on the turntable, a drive from the motor for rotating the antenna about its horizontal axis, angle responsive means on the turntable having relatively movable parts one of which is connected to said frame and the other of which is moved in accordance with the position of the antenna, and means responsive to changes in the relative position of said parts from a predetermined position for generating a control voltage for the motor causing rotation of the antenna returning said parts to said predetermined position.

3. In combination, a directional antenna for mounting on a support subject to pitch and roll, drives for shifting the directive axis of the antenna in azimuth and elevation relative to the support, a frame journaled on the support on an axis perpendicular to the plane of the azimuth and elevation of the directive axis of the antenna relative to the support, a stable vertical for holding the frame horizontal in a plane per-

pendicular to said first plane, and means responsive to the elevation angle in said first plane between the directive axis of the antenna and the frame for controlling the elevation drive to maintain said angle at a predetermined value.

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