

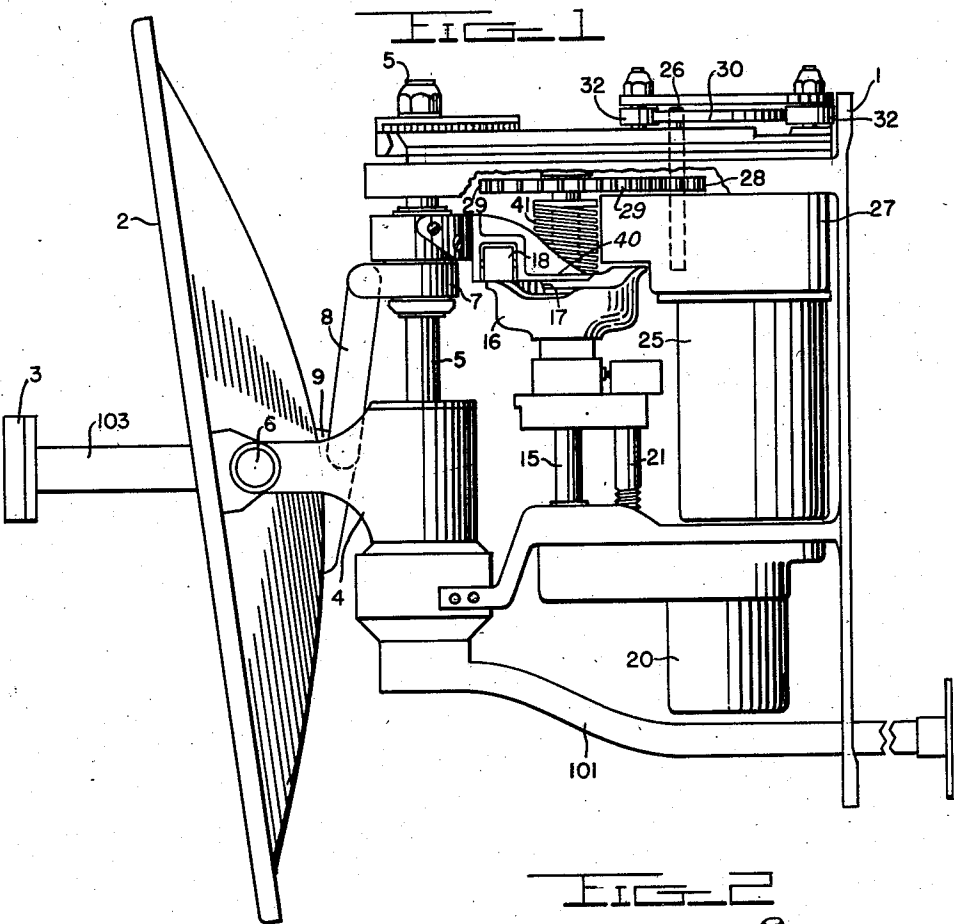
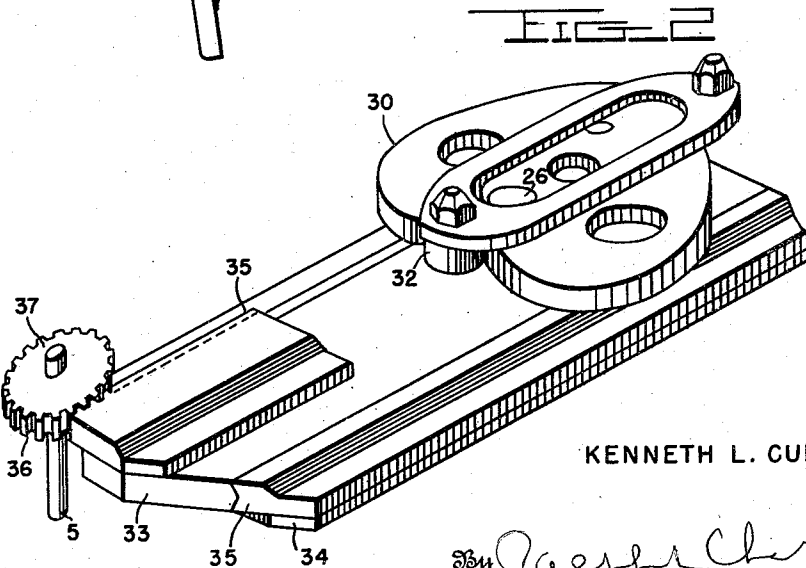
May 11, 1954

K. L. CURTIS
RADIATOR SYSTEM

2,678,394

Filed Oct. 10, 1945

3 Sheets-Sheet 1



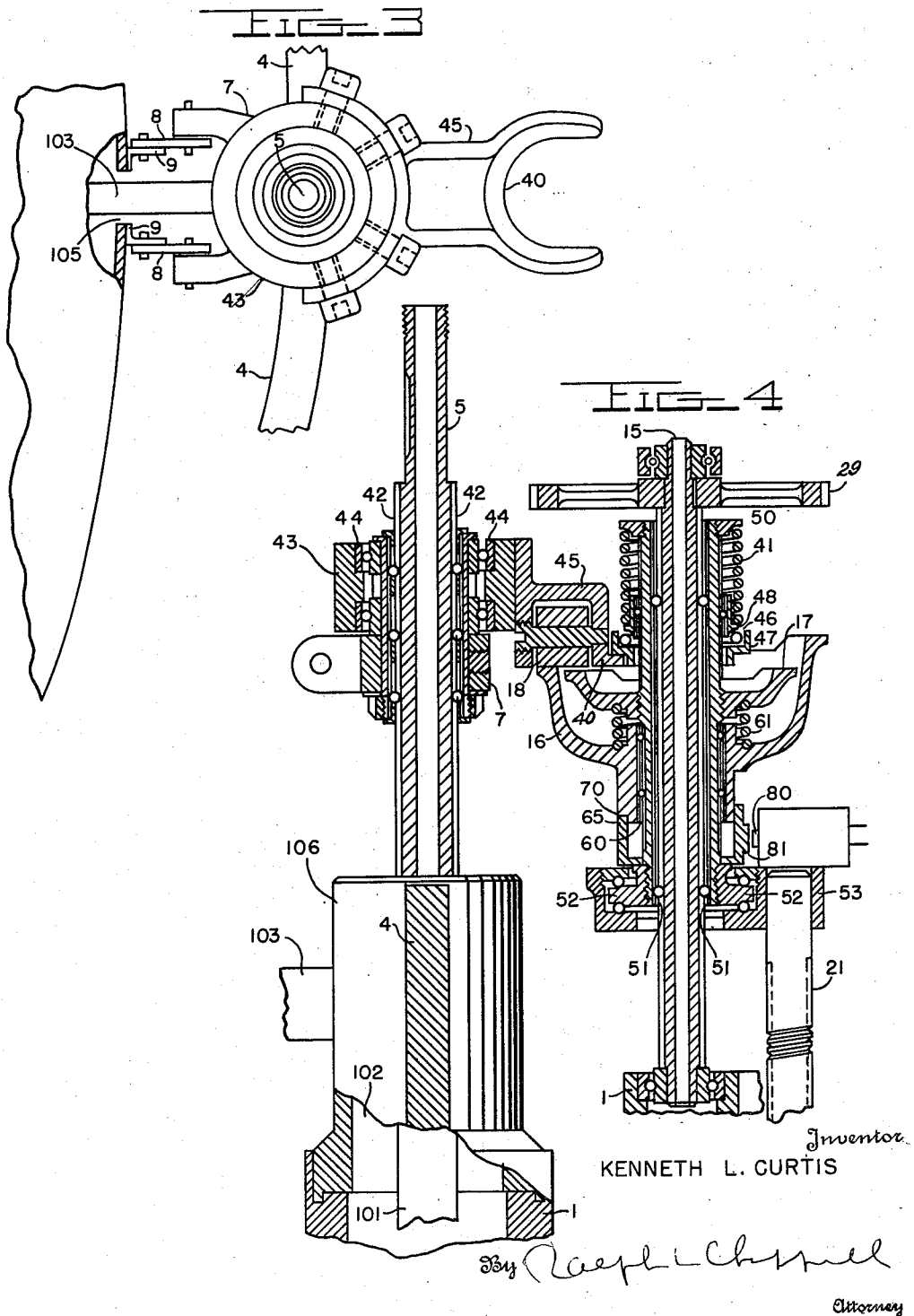
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RADIATOR SYSTEM

3 Sheets-Sheet 2



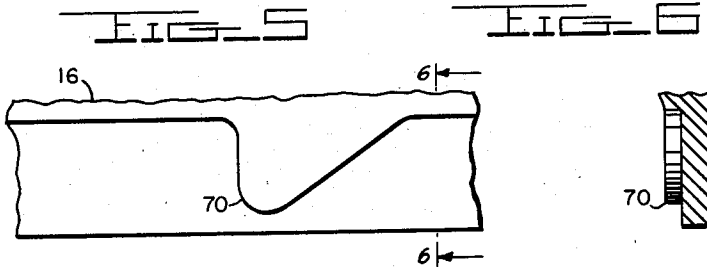
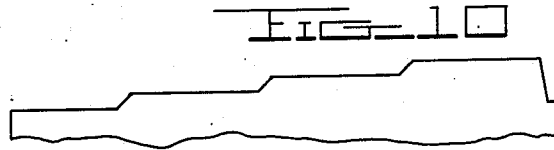
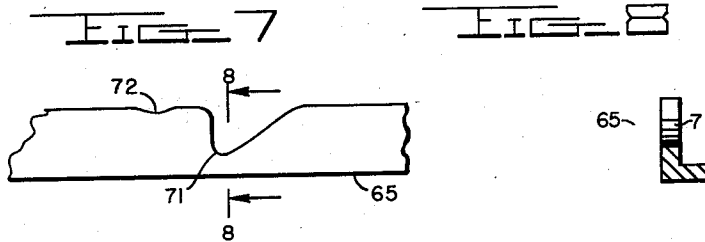
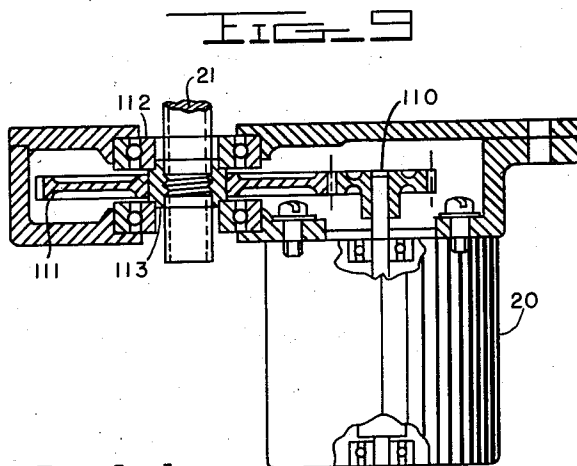
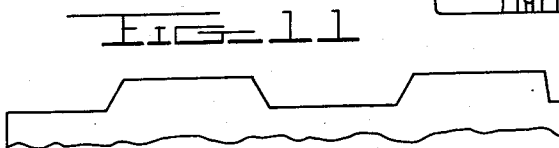
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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

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RADIATOR SYSTEM

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2 Claims. (Cl. 250—33.65)

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sec. 266)

1

This invention is directed to the problem of space scanning with a radiant energy beam, and relates particularly to means for directing such a beam suitable for use with echo ranging systems.

In echo ranging, where it is desired to know the obstacle distribution through a solid angle, the beam is swept recurrently over a locus in the desired area, and the range of obstacles at different directions is indicated by the echo receiver.

It is a primary object of the invention to provide means for space scanning by controlled variation in the orientation of a directional radiator.

It is a further object of the invention to provide means for space scanning over a plurality of conical segments.

The present invention contemplates accomplishing these objects by employing a directional radiator mounted on an oscillating shaft, and providing additional means for controlling the direction of the radiator in a plane passing axially through the shaft. Normally, the mounting shaft is vertically positioned and sweeps the beam in azimuth. The second mentioned control tilts the radiator to determine the angular elevation of the beam. In the preferred embodiment, the elevation is shifted between each successive sweep in azimuth to trace the desired sweep pattern.

The invention will be further described in connection with the drawings in which:

Fig. 1 shows a side view of the preferred embodiment of the present invention,

Fig. 2 shows a perspective view of the oscillating mechanism for a directive antenna,

Fig. 3 is a plan view of the antenna mounting shaft and its associated mechanism,

Fig. 4 is a sectional view of the mounting shaft and the cam shaft together with the mechanism carried thereby,

Fig. 5 shows in evolution the exterior surface of a cam member,

Fig. 6 shows a section along the line 6—6 of Fig. 5,

Fig. 7 shows in evolution the internal surface of a cam collar,

Fig. 8 shows a sectional view taken along the lines 8—8, of Fig. 7,

Fig. 9 is a view partially in section of the tilt control motor assembly for controlling the angle of tilt of the directional antenna,

Fig. 10 shows in evolution the operative surface of a tilt control cam, and

Fig. 11 shows in evolution the operative surface of a second tilt control cam.

2

The complete scanning unit as shown in Fig. 1 is assembled on frame member 1. The directional antenna comprises parabolic reflector 2, coaxing with radiating member 3 to direct a beam of radiant energy in accordance with the orientation of reflector. In the usual echo ranging systems, the antenna is employed both for impulse radiation and echo reception. The reflector member is mounted in yoke 4 for azimuthal orientation, and is tiltable therein on either side at pivots 6 for elevation orientation.

The bearing of the directional antenna is controlled by mounting shaft 5, which is integrally connected to yoke 4. The elevation of the reflector axis is determined by the position of tilt collar 7 on shaft 5. Collar 7 is coupled to the reflector by link 8 pivoted to lug 9, which is integral with the reflector. Tilt collar 7 is slidably mounted by splining 42 on shaft 5 for axial movement relative thereto under operation of the tilt control cam mechanism.

In the operation of the device, mounting shaft 5 is continuously oscillated to sweep the radiant energy beam around a horizontal path whose elevation is determined by the position of tilt collar 7 during the sweep. By means to be further described, tilt collar 7 is successively positioned for the desired elevation during each sweep oscillation. For this purpose cam shaft 15 is provided, carrying cams 16 and 17 which are shaped to the desired configurations on their upper surfaces. These cams are selectively operable to contact roller 18 for controlling the tilt collar.

The mean tilt angle is determined by the axial position of the cam members on shaft 15, and for this purpose they are splined thereon, and positionable by tilt control motor 20. The latter raises and lowers the cam assembly on shaft 15 by means of jack screw 21, as shown in Figs. 4 and 9.

Tilt control motor 20 is coupled to jack shaft 21 through the gear mechanism shown in Fig. 9. This consists of drive gear 110, which engages gear 111 journaled at 112 and carrying internally threaded nut 113. The latter externally engages jack shaft 21, and it is apparent that the vertical position of the latter may be controlled through suitable operation of motor 20. By this mechanism the mean tilt position of reflector 2 with respect to mounting frame 1 may be selected and through the operation of cam members 16 or 17 the reflector will be suitably positioned for each transverse sweep.

Operation of the scanning mechanism is pro-

3

vided by drive motor 25, which is coupled to main drive shaft 26 through reduction gear box 27.

Drive shaft 26 simultaneously rotates cam shaft 15, and by a suitable linkage to be described, synchronously oscillates control shaft 5. Shaft 26 carries gear 28 driving gear 29 on shaft 15 for operating the cam mechanism.

As best shown in Fig. 2 shaft 26 carries a cardioid cam 30 which coacts with followers 32 carried on slide 33. The latter is slidably mounted on plate 34 in ways 35, and the assembly is mounted on the upper surface of frame 1. Slide 33 at its outer end carries rack section 36, which engages gear 37 on the upper end of mounting shaft 5.

Cam 30 is shaped to have a uniform dimension crosswise through its center of rotation and consequently operates with continuous contact to each follower 32 to oscillate slide 33 substantially without lost motion. Rack 36 therefore oscillates shaft 5 through gear 37 and produces the desired horizontal scanning of reflector 2.

Tilt collar 7 is splined at 42 on shaft 5, so that it is oscillated therewith, as shown in Fig. 4. Annular member 43 is journaled on the outer surface of collar 7 at 44 and carries member 45, which includes yoke 40. Consequently yoke 40 and cam collar 18 do not constrain shaft 5 in its oscillation.

Radiating element 3 is energized through wave guide 101, which passes upwardly through chamber 102. This chamber is formed centrally in yoke 4 which is affixed to the lower end of mounting shaft 5. As shown in Fig. 4 the yoke assembly is journaled on the frame member 1 at the lower inside edge of chamber 102. Wave guide 101 is coupled to the radiator 3 through guide section 103. The latter is provided with a rotatable coupling joint to guide 101 within chamber 102. Such rotatable couplings are well known in the art, and may be of any desired construction. This coupling is coaxial with shaft 5, and guide section 103 is rigidly mounted on the yoke to oscillate therewith. A vertically elongated aperture 105 is provided in reflector 2 to permit passage of waveguide section 103 and to provide clearance for the tilting movement of the reflector.

As shown in Figs. 3 and 4, tilt collar 7 splined on shaft 5 is axially controlled by yoke 40 of member 45. The latter member carries a cam following roller 18 engageable with the tilt control cams 16 or 17. As shown in Figs. 1 and 4, yoke 40 is spring pressed downwardly by spring 41 to maintain engagement between the roller and cam surface.

Thrust bearing 46 is interposed between yoke 40 and spring 41 to permit the latter to rotate freely with shaft 15. The thrust bearing comprises an outer member 47 engaging the upper face of yoke 40 and an inner member 48, which is splined on sleeve 50, mounted for rotation with shaft 15. Consequently tilt collar 7 is continuously maintained in an axial position on shaft 5 controlled solely by cam member 16 or 17.

Cam 17 is affixed to sleeve 50 intermediate of its length. Sleeve 50 is splined on shaft 15 at 51, and is journaled at its lower extremity in block 53 by bearing 52. Block 53 is vertically positioned by jack screw 21 which thereby controls the position of cam 17. Cam 16 is splined at 60 on the outer surface of sleeve 50 below cam 17, and is spring-pressed downwardly thereon by spring 61. The cams 16 and 17 are selectively placed in operation by controlling their relative

4

axial positions. In Fig. 4 cam 16 is elevated and therefore is engaged by roller 18.

The axial position of cam 16 is controlled by floating collar 65, which engages its lower surface. Collar 65 rests on the upper surface bearing 52, and rotates with shaft 15.

As shown in Figs. 5 and 6 the lower neck of cam 16 is provided with an outwardly extended portion 70. This extension constitutes a cam surface coacting with complementary portions of floating collar 65. The latter are shown in Fig. 7, and comprise a deep recess 71 and a shallow recess 72. A section of floating collar 65 taken through deep recess 71 is shown in Fig. 8. In the position shown in Fig. 4 cam surface 70 of cam member 16 rides in shallow recess 72. In order to shift the position of cam 16 the solenoid actuated member 80 may be extended to engage detent 81 carried on the outer face of collar 65. This operation arrests the rotation of collar 65 and causes cam surface 70 to ride up out of shallow recess 72 and around the upper face of collar 65 until it seats in deep recess 71 under operation of spring 61. The solenoid may then be deenergized to permit retraction of member 80 by a biasing spring. In this position the upper cam surface of 16 is at all points below the upper surface of cam 17, on which roller 18 then rides.

In the embodiment shown the upper face of cam 16 is formed in 4 sectors at successively increasing heights, as shown in evolution in Fig. 10. In Fig. 11 cam 17 is shown in evolution and provides only two positions, opposite sectors having the same height. In this case, therefore, the reduction effected by gears 28 and 29 coupling drive shaft 26 to cam shaft 15 is two to one. Each horizontal sweep, of which two occur for each revolution of shaft 26, is transversed while follower 18 dwells on a quadrant of the operative cam surface, and the timing is selected to effect elevational shifts during the extreme positions of the horizontal sweep.

It will be understood that the embodiment shown is exemplary only, and that the scope of the invention will be determined with reference to the appended claims.

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

What is claimed is:

1. A scanning system comprising a directive antenna, rotatable mounting shaft means carrying the antenna, a drive shaft parallel to the mounting shaft, cam means driven by said drive shaft coupling the drive shaft to the mounting shaft operative under continuous rotation of the drive shaft to oscillate the mounting shaft, a cam shaft driven from said drive shaft at half the angular speed, a first circular tilt cam on the cam shaft having a plurality of first tilt cam surfaces at varying axial positions of said cam shaft, cam follower means engageable with the first tilt cam surfaces operatively coupled with the directive antenna to tilt the same in dependency on the cam means, second circular tilt cam means on the cam shaft having a plurality of second tilt cam surfaces spaced axially of the cam shaft and different in number from the first cam surfaces, and tilt cam positioning means operative to effect engagement of the cam follower and the second tilt cam surface with disengagement of the first tilt cam surface.
2. A scanning system comprising a directive

5

antenna, rotatable mounting shaft means carrying the antenna, a drive shaft parallel to the mounting shaft, cam means driven by said drive shaft coupling the drive shaft to the mounting shaft operative under continuous rotation of the drive shaft to oscillate the mounting shaft, a cam shaft driven from said drive shaft at half the angular speed, a first circular tilt cam on the cam shaft having a plurality of first tilt cam surfaces at varying axial positions of said cam shaft, cam follower means engageable with the first tilt cam surfaces operatively coupled with the directive antenna to tilt the same in dependency on the cam means, second circular tilt cam means, spline mounting means slidably mounting the second tilt cam means around the cam shaft, the second tilt cam means having a plurality of second tilt cam surfaces spaced axially of the cam shaft and different in number from the first

6

cam surface, and axial positioning means connected with the second tilt cam means operative to effect engagement of the cam follower and the second tilt cam surface with disengagement of the first tilt cam surface.

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