March 26, 1968 J. LAIBSON 3,375,523

ANTENNA STRUCTURE MOVABLE IN AZIMUTH AND ELEVATION DIRECTIONS

Filed Oct. 16, 1964 5 Sheets-Sheet 1

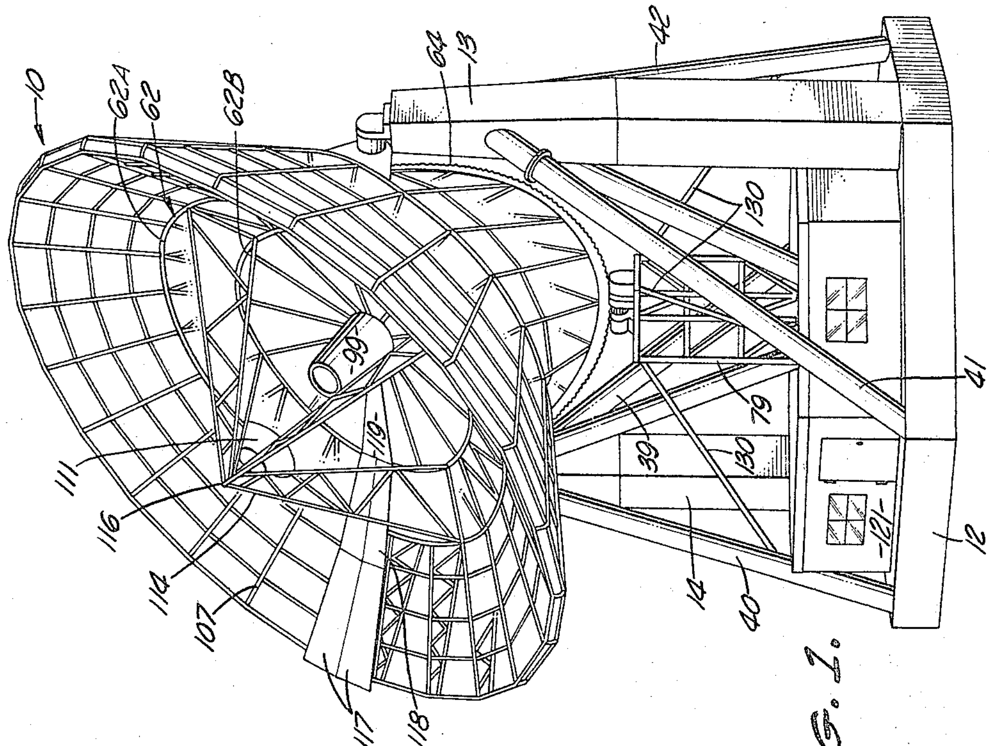

FIG. 1.

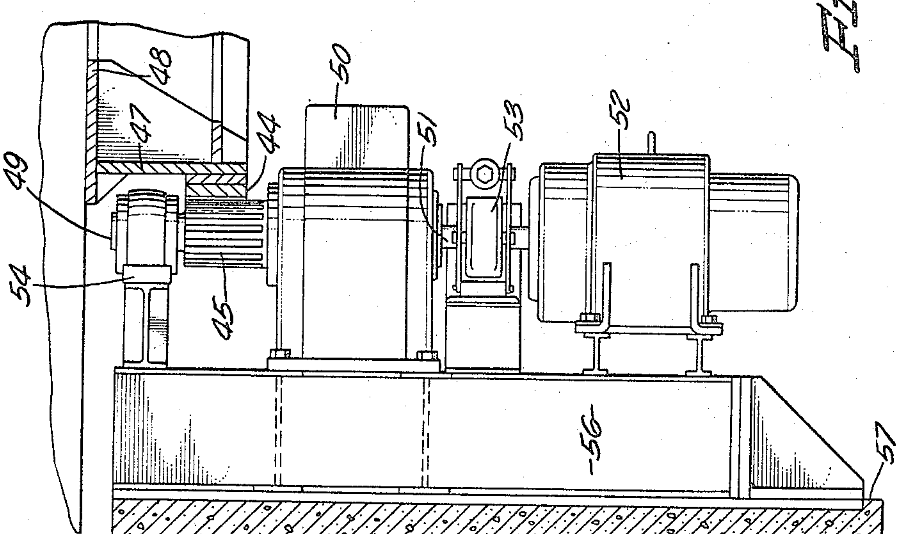

FIG. 4.

JERRY LAIBSON
INVENTOR.

BY Lyon & Lyon

ATTORNEYS

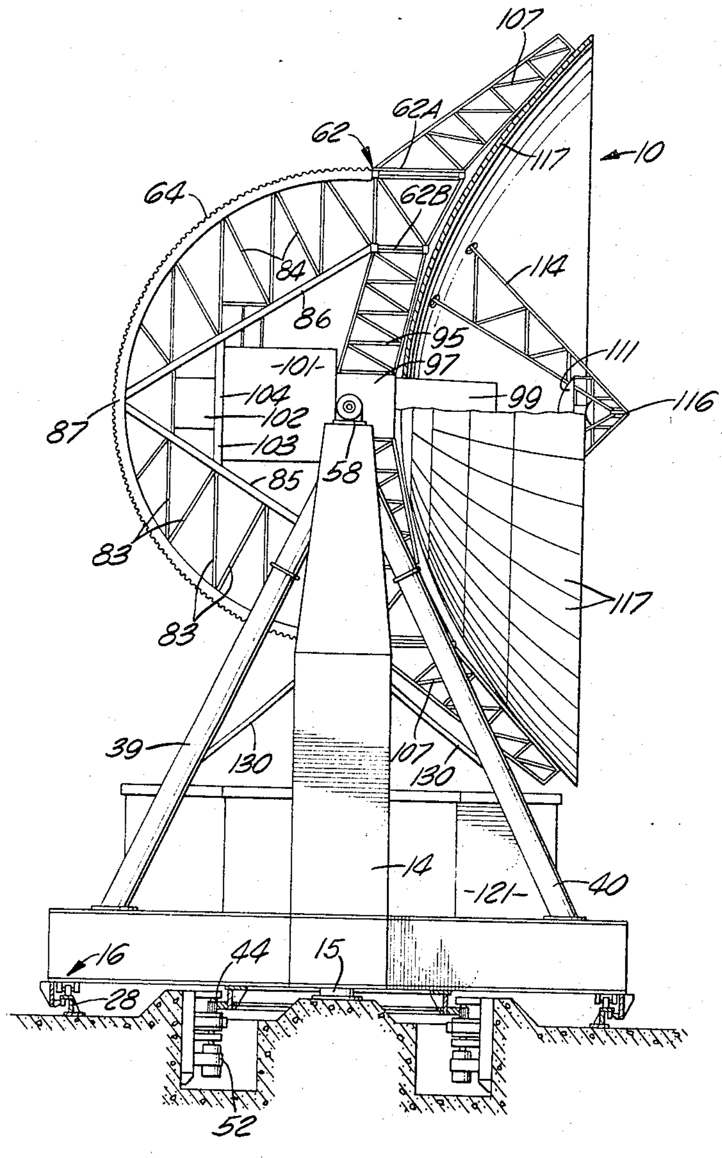

FIG. 2.

JERRY LAIBSON
INVENTOR.

BY Lyon & Lyon

ATTORNEYS

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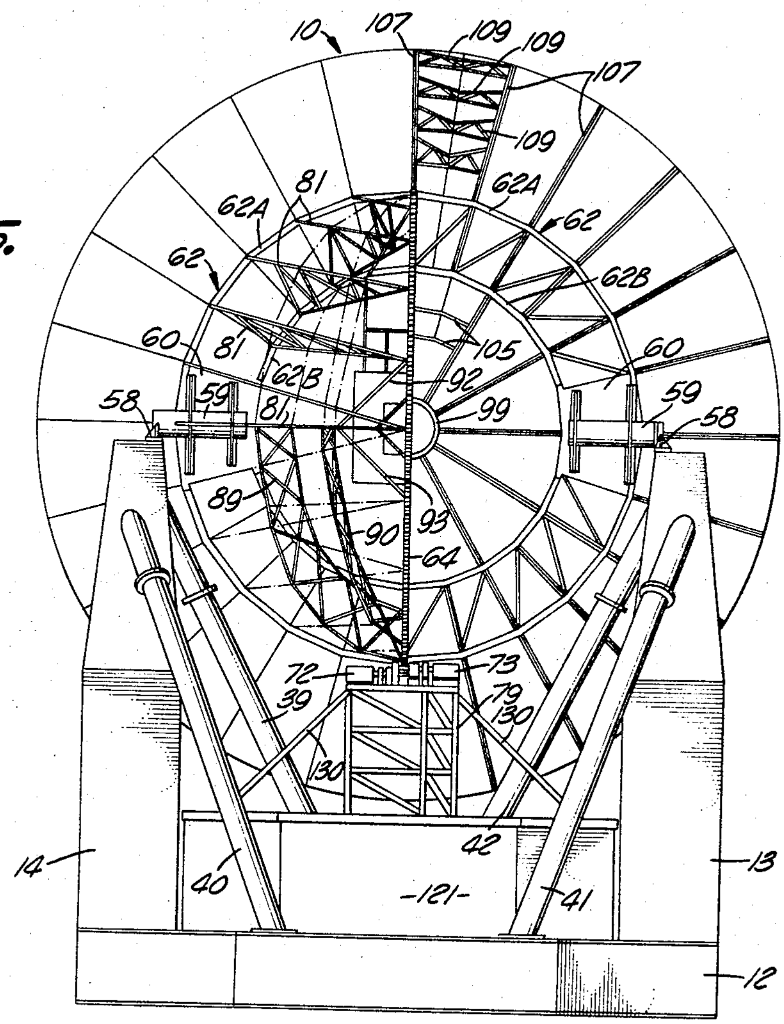
FIG. 5.



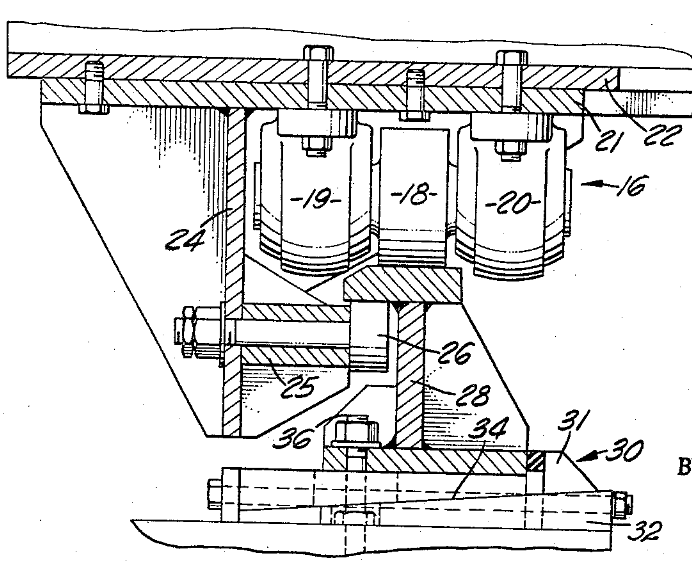


FIG. 3.

JERRY LAIBSON
INVENTOR.

BY Lyon & Lyon

ATTORNEYS

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ANTENNA STRUCTURE MOVABLE IN AZIMUTH AND ELEVATION DIRECTIONS

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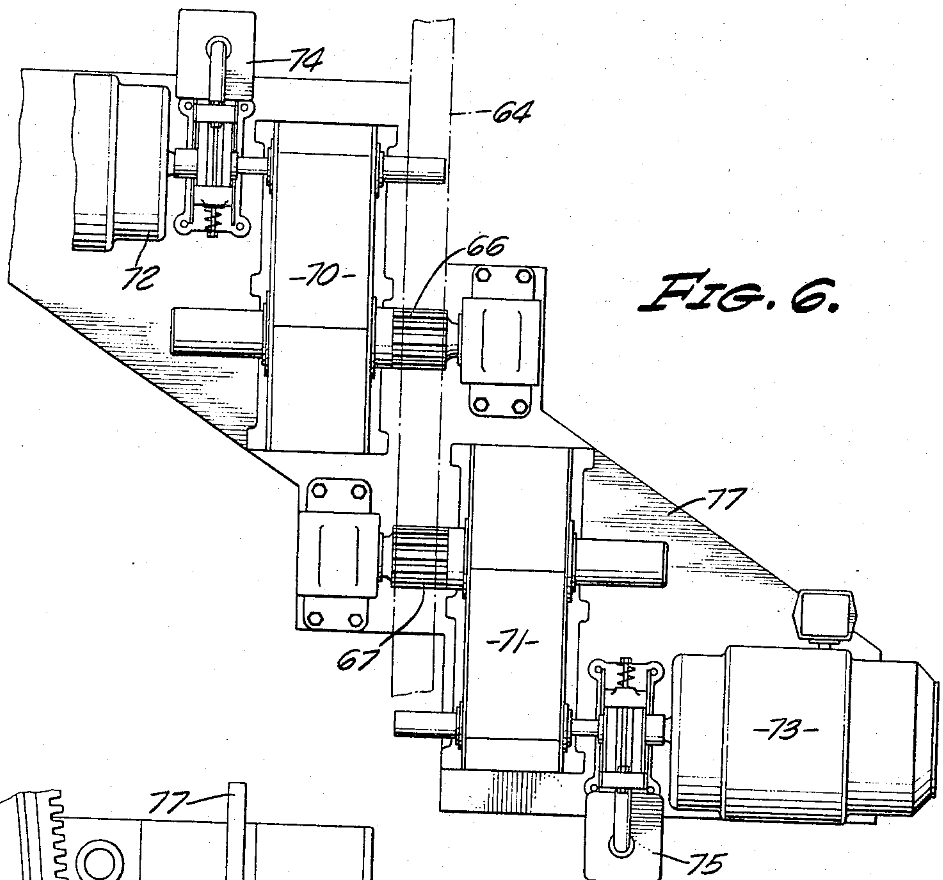

FIG. 6.

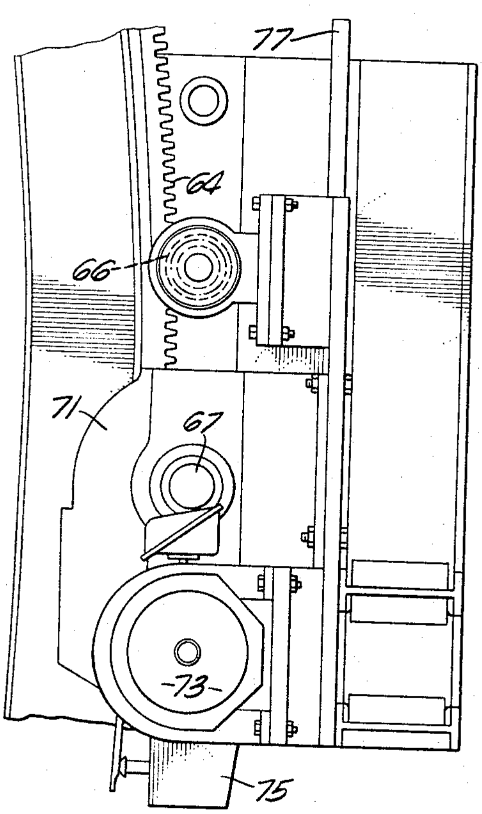

FIG. 7.

JERRY LAIBSON
INVENTOR.

BY Lyon & Lyon

ATTORNEYS

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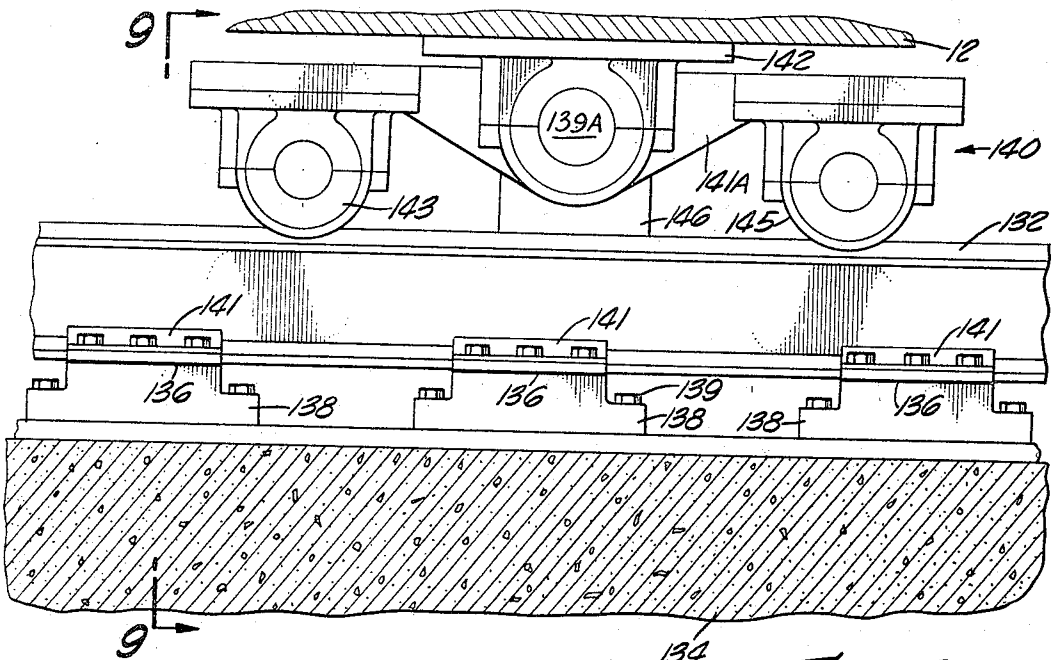

FIG. 8.

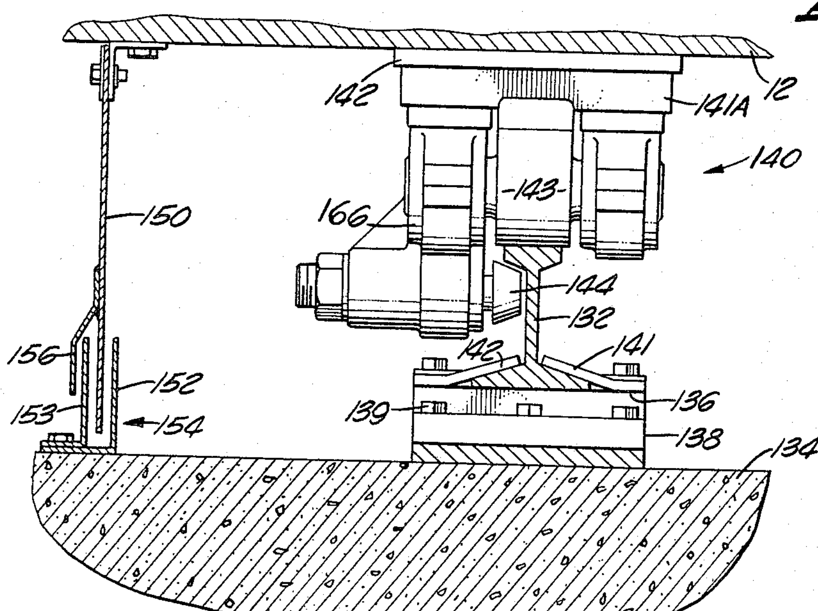

FIG. 9.

JERRY LAIBSON
INVENTOR.

BY Lyon & Lyon

ATTORNEYS

United States Patent Office

3,375,523

Patented Mar. 26, 1968

3,375,523

ANTENNA STRUCTURE MOVABLE IN AZIMUTH AND ELEVATION DIRECTIONS

Jerry Laibson, San Diego, Calif., assignor to Whittaker Corporation, Los Angeles, Calif., a corporation of California

Filed Oct. 16, 1964, Ser. No. 404,469
6 Claims. (Cl. 343—765)

ABSTRACT OF THE DISCLOSURE

A parabolic reflector is mounted for movement in either azimuth or elevation or both simultaneously. The elevation axis is close to the center of gravity of the antenna system for minimizing inertial effects and drive requirements, with a single centrally located large sector elevation gear and other equipment being mounted as a part of the reflector counterweight. A circular gear is mounted on the turntable directly over a pit housing and is engaged by an azimuth drive system. The turntable supports a tripod type tower which allows adjustment in elevation of the reflector over a large range. The reflector alternatively instead of being supported on a tripod type tower may be supported on a yoke.

The present invention relates to an improved antenna construction.

It is therefore a general object of the present invention to provide an improved antenna construction of the character indicated above.

A specific object of the present invention is to provide a reflector movable about a horizontal or elevation axis which is close to the center of gravity of the antenna system thereby minimizing deflections and inertial and drive requirements and making possible the direct use of a large elevation gear, the electronic cages and other miscellaneous equipment as a part of the reflector counterweight, with the large elevation gear serving also to increase the pointing accuracy of the drive system and minimizing costs of a speed reduction unit, and further with the elevation gear forming an integral part of the reflector supporting structure for overall stability and satisfaction of frequency requirements.

Another specific object of the present invention is to provide an antenna of this character wherein its turntable is capable of supporting a large computer room and the elevation drive system and which in general simplifies the data take-off design.

Another specific object of the present invention is to provide an antenna construction of this character which is compact with resulting high strength to weight ratio, i.e. lightness, and antenna efficiency.

Another object of the present invention is to provide an antenna construction of this character using a low tower whereby maintenance and adjustment of the antenna may be accomplished from the ground using simple scaffolding.

Another specific object of the present invention is to provide an antenna construction of this character wherein the azimuth structure includes a tripod-tower structure which provides stability in all directions with X-band rigidity requirements.

Another specific object of the present invention is to provide an antenna construction of this character wherein the turntable is mounted on a center king post and an outer circular track with the same forming a direct load path for truss loads and overturning moments.

Another specific object of the present invention is to provide an improved reflector structure wherein there are close ties between a large torus ring and radial panel sup-

porting beams for increased rigidity, antenna stability, frequency characteristics, and pointing accuracy, resulting in large part due to the torsional strength of the torus and balance between outer and inner structural areas.

Another specific object of the present invention is to provide a reflector construction making use of a torus ring configuration that permits a fixed stable tie for mounting of spars and trusses to thereby reduce spar deflections and increase natural frequency and pointing accuracy.

Another specific object of the present invention is to provide a reflector construction using a spar system having rectangular truss work with large depth in the radial plane to thereby achieve a high natural frequency for the overall spar system with maximum reduction of shadow area.

Another specific object of the present invention is to provide a reflector construction in which the center hub area provides (a) rigidity to the torus ring, (b) a support for the antenna feed, (c) an integral unit with the electronic room, and (d) a mounting platform for a parabolascope type instrument during panel alignment.

Another specific object of the present invention is to provide a reflector construction of this character wherein the radial beams for panel support provide rigidity in all directions, with also the interaction between radial and circumferential trusses providing great torsional rigidity and increased torsional natural frequency.

Another specific object of the present invention is to provide a simple construction for minimizing costs of fabrication, field assembly and shipping with elements being of complete, bolted or welded construction.

The features of the present invention which are believed to be novel are set forth with particularity in the appended claims. This invention itself, both as to its organization and manner of operation, together with further objects and advantages thereof, may be best understood by reference to the following description taken in connection with the accompanying drawings, in which:

FIG. 1 is a perspective view of the reflector and its mounting in a partly assembled condition.

FIG. 2 is a view partly in side elevation and partly in section transversely through a portion of the reflector of FIG. 1, with additional reflecting panels thereon, and also illustrates the azimuth drive system.

FIG. 3 illustrates in more detail the mounting of the reflector mount on a track shown also in FIG. 2.

FIG. 4 illustrates in more detail the motor drive of the azimuth drive system shown also in FIG. 2.

FIG. 5 is a view partly in front elevation and partly in section of the reflector assembly.

FIG. 6 illustrates details of the elevation drive system.

FIG. 7 is generally a view in side elevation of the drive system shown in FIG. 6.

FIGS. 8 and 9 illustrate a preferred form of track and truck structure used in rotatably supporting the turntable, FIG. 8 being generally a view in side elevation and FIG. 9 being a view taken in the direction indicated by the lines 9—9 in FIG. 8.

The antenna reflector **10** is mounted for rotation in azimuth and in elevation, azimuth adjustment being provided by the rotatable turntable or pedestal **12** mounting a pair of towers **13** and **14**, and elevation adjustment being provided by rotatably supporting the reflector **10** on the upper ends of such towers **13** and **14**.

The turntable or pedestal **12** is centrally supported for rotation on a stationary king post **15** (FIG. 2) anchored in the ground, using suitable bearings (not shown) for that purpose, and the turntable has secured thereto six track engaging trucks **16**, equally spaced around the circumference of a circle, one of which is illustrated in FIGS. 2 and 3.

As seen in FIG. 3, the truck **16** includes a rail engaging roller **18** rotatably supported in bearings **19**, **20** on a mounting plate **21** which in turn is releasably and adjustably mounted on the turntable plate **22** using shims, if necessary, for adjustment. Also, the plate **21** is provided with a downwardly extending angled bracket member **24** carrying a bearing **25** for a roller **26** which engages the underside of a flanged portion of circular rail **28** in the general form of an I-beam in cross-section.

The rail **28** is mounted at different spaced locations along its circular length on an adjustable support **30** which includes an upper plate **31** and a lower plate **32** engaging on mating pitched or cam surfaces **34**, the plate **32** being anchored to the ground, the overall height of the support **30** being adjusted by the bolt **34** passing through apertured portions of plates **31**, **32**, and such adjustment being secured by bolt **36**.

The adjustments are so made that substantially all of the weight of the turntable is supported by the rail **28** and substantially equally at six different points, with tilting of the turntable being prevented under adverse conditions by engagement of the roller **26** with the rail **28**.

The drive for the turntable **12** is shown in FIGS. 2 and 4 and involves generally a circular bull gear **44** on the turntable **12** meshing with a motor driven gear **45**, the gear **44** being mounted on a reinforced flange **47** extending downwardly from the turntable plate **48**, and the gear **45** being on the output shaft **49** of a speed reducer unit **50** having its input shaft **51** driven by a motor **52**. A solenoid operated brake **53** is associated with shaft **51** to brake movement of the shaft and lock the turntable in position. The reducer unit **50**, brake **51**, motor **52** as well as a bearing **54** for shaft **49** are mounted on a common supporting member **56** which is secured to an inner wall of an underground pit **57**. Azimuth adjustment is obtained by releasing brake **53** and energizing motor **52** which may be a reversible motor.

The turntable **12**, as indicated in the drawings, is formed of a plurality of interconnected truss members to which plates are secured for connection to the two towers **13**, **14** and their braces **39**, **40**, **41** and **42**.

The reflector **10** is rotatably supported about a common horizontal axis on each of the towers **13**, **14** for elevation adjustment using bearing means which may include a shaft supported on each of the towers at its support **58**, with such shaft extending into a bearing sleeve **59** mounted on its supporting plate **60**, the plate **60**, as illustrated, being secured to the torus ring **62** of the reflector **10**.

Also secured to the reflector torus ring **62** is a large circular gear **64** (FIG. 2) meshing, as shown in FIGS. 6 and 7, with a pair of motor driven gears **66**, **67**, the gear **66** being used to drive the reflector in the aft direction and the gear **67** being used to drive the reflector in the forward direction. Each of these two gears **66**, **67** are driven by a like arrangement involving, correspondingly, a speed reducer unit **70**, **71** and a corresponding motor **72**, **73**, with a solenoid operated brake **74**, **75** being associated with the output shaft of the corresponding motor **72**, **73**.

These various motors, speed reducer units and brakes shown in FIG. 6 are mounted on a common support plate **77** secured to the upper end of a supporting structure **79** on and extending upwardly from turntable **12**.

This elevation drive gear **64** is, as previously indicated, secured to the reflector torus ring **62** using, as indicated in FIG. 5, a series of generally triangularly shaped truss members **81** each having their apexes connected to the ring gear **64** and their base portions secured to inner and outer rings **62A**, **62B** of the torus ring **62**; and additional support is provided for the gear **64**, as shown in FIG. 2, by a series of support members **83** and **84** extending between the gear **64** and a corresponding frame member **85**, **86**, each of which has one of its ends interconnected at a common point **87** on gear **64** and which has its other end connected to the inner ring **62B** of the torus **62** to define therewith a generally triangular structure having its plane

lying within the plane of the circular gear **64**. The extremities of the circular gear **64** are connected, as also indicated in FIG. 2, to the outer ring **62A** of torus **62**. Also, as indicated in FIG. 5, the series of radial trusses **81** may be interconnected intercostally by a first series of interconnected intercostal members **89** and also by a second series of intercostal members **90** which are disposed radially inwardly of the first series of members **89**. Further triangular bracing may be provided by a series of members **92**, **93** in FIG. 5 each of which has one of its ends interconnected at a common point to the median truss **81** and the other one of its ends connected respectively to the members **85**, **86** (FIG. 2) to thereby provide enhanced support at the rotational axis of the reflector.

Extending radially inwardly is a series of center hub truss supports **95**, each of which is connected at its outer end to the torus ring member **62B** (FIG. 2), with the inner ends of such truss supports **95** being connected to the center hub structure **97** which includes the antenna feed housing **99** and electronic cage **101**, such cage **101** and an associated air conditioner unit **102** being disposed aft of the elevation axis and being additionally supported by a brace structure **103** extending between the supporting members **85**, **86**. These center hub truss supports **95**, as seen in FIG. 5, are interconnected by intercostal members **105**.

Extending radially outwardly from the torus ring **62** and connected to the outer torus ring member **62** is a series of major panel support trusses **107** (FIGS. 2 and 5) which are interconnected at different radial distances by intercostal truss members **109**.

A subreflector **111** positioned forwardly of the elevation axis is supported on and near the ends of four generally triangularly shaped spars **114**, having their base portions connected to torus ring **62** at equally spaced circumferential points thereon, with the apieces of the spars being interconnected forwardly at their junction **116**.

The reflecting surface of the reflector is defined by three series of panels **117**, **118**, **119**, as indicated in FIG. 1, of conventional honeycomb structure, the panels, generally gore-shaped, being suitably secured in alignment on the radial trusses **107**, torus **62** and center hub trusses **95** to form a parabolic reflecting surface.

A computer room **121** is mounted on the turntable **12** between the towers **13**, **14** and cables (not shown) extend to such room for controlling or adjusting the position of the reflector and also for controlling the transmission of energy from the antenna and for collecting data from use of the antenna.

It will be seen that the vertical axis of the king pin **15** about which the turntable is rotatable, when projected, passes through the horizontal or elevation axis of the reflector which itself passes very near or actually through the center of gravity of the reflector assembly.

It will be appreciated that the reflector may be supported other than by the towers illustrated. For example, a generally Y-shaped or yoke structure may be used having a portion partially encircling the reflector and having the reflector supported on the upper arms thereof.

Preferably the housing **121** is of hexagonal shape making most efficient use of the space above the turntable **12** upon which the same is constructed.

Also, to provide added rigidity to the supporting structure **79**, four brace members **130** extend between the upper end of the structure **79** and an intermediate point on a corresponding one of the four tower braces **39**, **40**, **41** and **42**.

Referring to FIGS. 8 and 9, the construction is a modification of the arrangement shown in FIG. 3. The rail **132** of standard cross-section, formed in arcuate sections, is adjustably mounted on a concrete base **134** using shims **136** of different thickness to assure the positioning of the top of the completed track in a horizontal plane. These shims **136** are between the lower rail flange and a corresponding one of circumferentially spaced base members

138 secured by bolts 139 to the concrete base or footing 134, and such shims are maintained by angled clamping members 141, 142 bolted to the base member 138 to engage opposite sides of the lower rail flange with the shim 136 being sandwiched between, one the one hand, the base member 138 and, on the other hand, the rail 132 and the clamping members 141, 142.

The turntable 12 mounts a plurality of circumferentially spaced truck structures 140, each of which includes a frame member 141A pivotally mounted about the axis 139A at its central portion on mounting bracket 142 which is secured to the turntable. This frame member 141A rotatably mounts three rail engaging wheels or rollers 143, 144, 145, the wheels 143, 145 engaging the top side of the rail, as shown in FIG. 8, and the intermediate wheel or roller 144 engaging the underside of the top rail flange, as seen in FIG. 9. For the latter purpose, the roller 144 is rotatably supported in a bracket member 166 integrally formed with the truck frame 141. It will be noted that the pivotal axis of the frame member 141 is in a vertical plane with the rotational axis of roller 144.

An annular dirt or dust screen 150 (FIG. 9) has its upper end secured to the turntable 12, with its lower end extending between the spaced walls 152, 153 of an annular trap structure 154; and an angle baffle member 156 extends partially around the outer wall 153 to provide a dirt or dust trap preventing dirt and dust from entering the central underside portion of the turntable 12.

While the particular embodiments of the present invention have been shown and described, it will be obvious to those skilled in the art that changes and modifications may be made without departing from this invention in its broader aspects and, therefore, the aim in the appended claims is to cover all such changes and modifications as fall within the true spirit and scope of this invention.

I claim:

1. In an antenna construction of the character described, a turntable having wheels engageable with a circular rail; a vertical king post on which said turntable is rotatable; a yoke type reflector supporting structure extending upwardly from said turntable; a reflector structure rotatably supported on opposite legs of said supporting structure about a horizontal axis; said reflector structure having a reflector surface lying forwardly of said horizontal axis and having a single centrally located semicircular gear extending aft of said horizontal axis with the center of curvature of said circular gear corresponding to said horizontal axis; said gear lying in a vertical plane central of said reflecting surface; a second supporting structure on said turntable and drive means mounted on said second supporting structure and engaging said gear to drive the same about said horizontal axis, said reflector structure including a torus ring rotatably supported on said supporting structure; a first series of radial trusses mounted on said torus ring and extending radially outwardly therefrom; a second series of radial trusses mounted on and extending radially inwardly of said torus ring; an antenna feed housing supported on the inner ends of said second series of trusses; reflecting members secured on said first and second series of trusses; said circular gear being secured to said torus ring; said torus ring including an inner and an outer ring member; a pair of frame members each having one of their ends connected to said inner ring member and the other one of their ends extending rearwardly and connected to a central portion of said gear; and a series of truss members between each of said frame members and said gear.

2. In an antenna construction of the character described, a turntable having wheels engageable with a circular rail; a vertical king post on which said turntable

is rotatable; a yoke type reflector supporting structure extending upwardly from said turntable; a reflector structure rotatably supported on opposite legs of said supporting structure about a horizontal axis; said reflector structure having a reflector surface lying forwardly of said horizontal axis and having a single centrally located semicircular gear extending aft of said horizontal axis with the center of curvature of said circular gear corresponding to said horizontal axis; said gear lying in a vertical plane central of said reflecting surface; a second supporting structure on said turntable and drive means mounted on said second supporting structure and engaging said gear to drive the same about said horizontal axis; said rail having a flange; means adjustably supporting said rail at a plurality of spaced points therealong; means adjustably supporting said wheels on said turntable; said wheels engaging the top side of said flange; and roller means mounted on said turntable and engaging an underside of said rail; said wheels and said roller means being mounted as a unit on said turntable.

3. An antenna construction as set forth in claim 2, in which said turntable has a circular gear mounted on its underside; and motor driven gear means engaging said gear on said turntable.

4. In an antenna construction of the character described, a turntable having wheels engageable with a circular rail; a vertical king post on which said turntable is rotatable; a yoke type reflector supporting structure extending upwardly from said turntable; a reflector structure rotatably supported on opposite legs of said supporting structure about a horizontal axis; said reflector structure having a reflector surface lying forwardly of said horizontal axis and having a single centrally located semicircular gear extending aft of said horizontal axis with the center of curvature of said circular gear corresponding to said horizontal axis; said gear lying in a vertical plane central of said reflecting surface; a second supporting structure on said turntable and drive means mounted on said second supporting structure and engaging said gear to drive the same about said horizontal axis; said rail having a flange; a frame member having a central portion thereof pivotally mounted about a pivotal axis on the underside of said turntable and having three rollers rotatably mounted thereon; each of two of said rollers being on ends of said frame member and contacting the topside of said rail; the third one of said rollers contacting the underside of said flange.

5. A construction as set forth in claim 4, in which the rotational axis of said third roller extends vertically in a vertical plane with the pivotal axis of said frame member.

6. An antenna construction as set forth in claim 5, including an annular dirt shield having one of its ends secured to the turntable and the other one of its ends extending between spaced annular walls of a stationary dirt trap member which cooperates with the lower end of said shield to provide a dirt trap.

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ELI LIEBERMAN, *Primary Examiner.*

HERMAN K. SAALBACH, PAUL GENSLER, *Examiners.*