Dec. 8, 1970 R. P. SELBY ET AL 3,546,704

SATELLITE TRACKING DISK ANTENNA WITH COARSE AND FINE DRIVING MECHANISM

Filed July 28, 1967 9 Sheets-Sheet 1

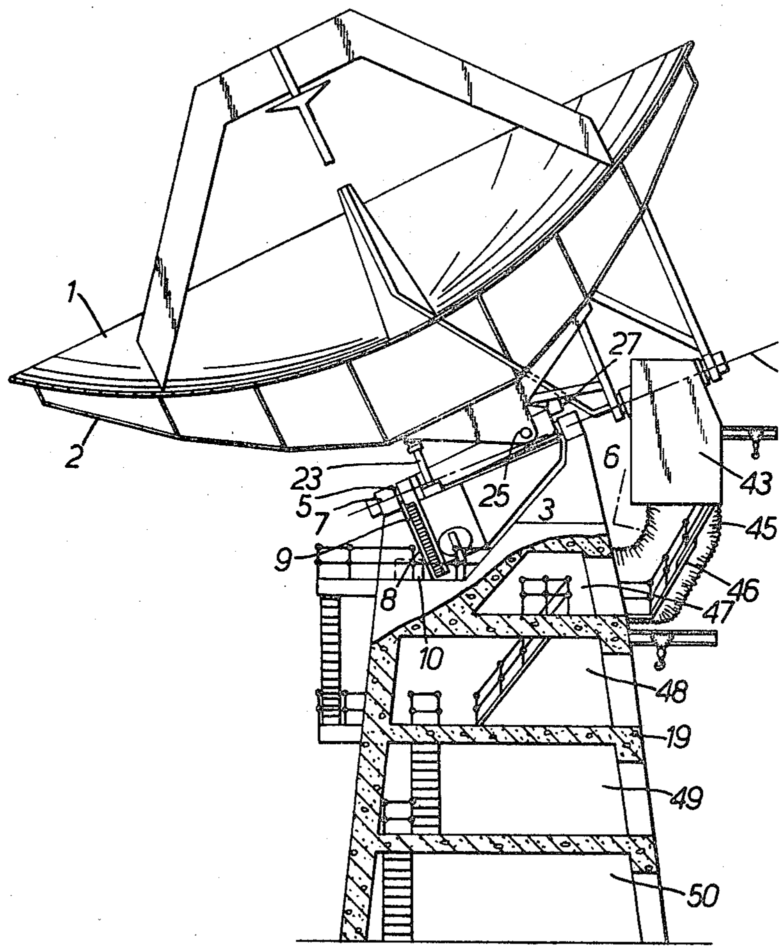

FIG. 1.

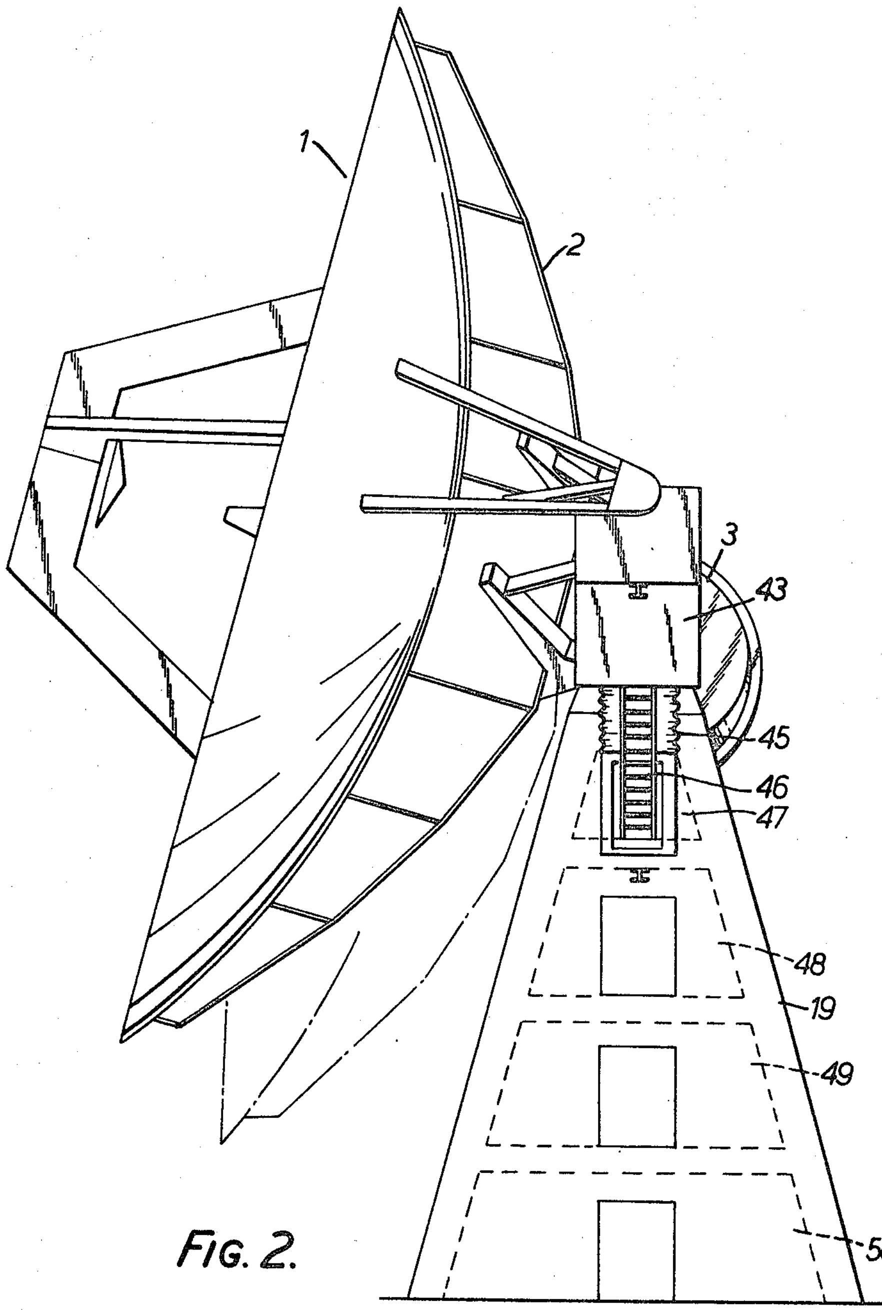

FIG. 2.

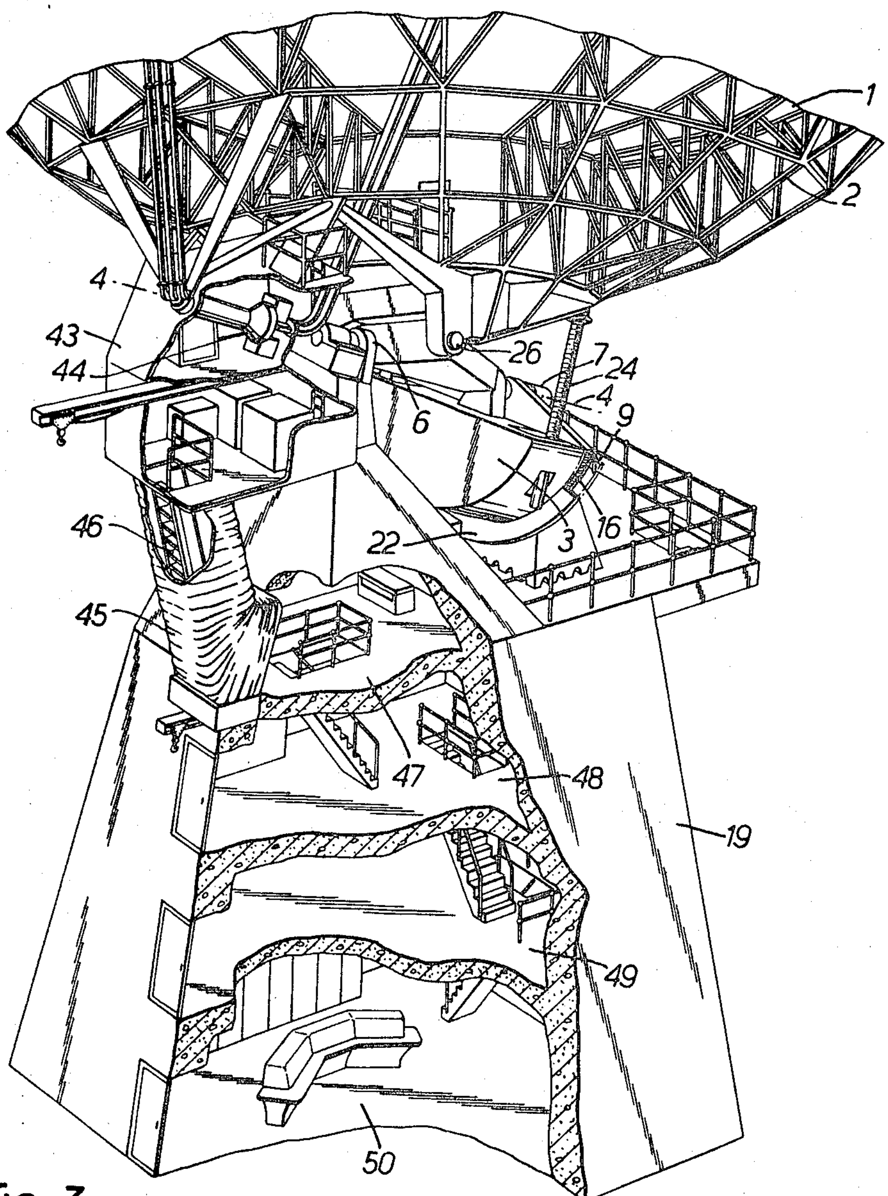

FIG. 3.

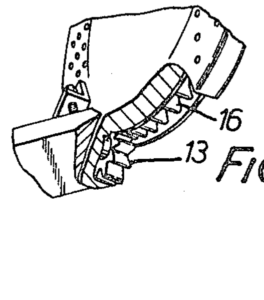

FIG. 3A

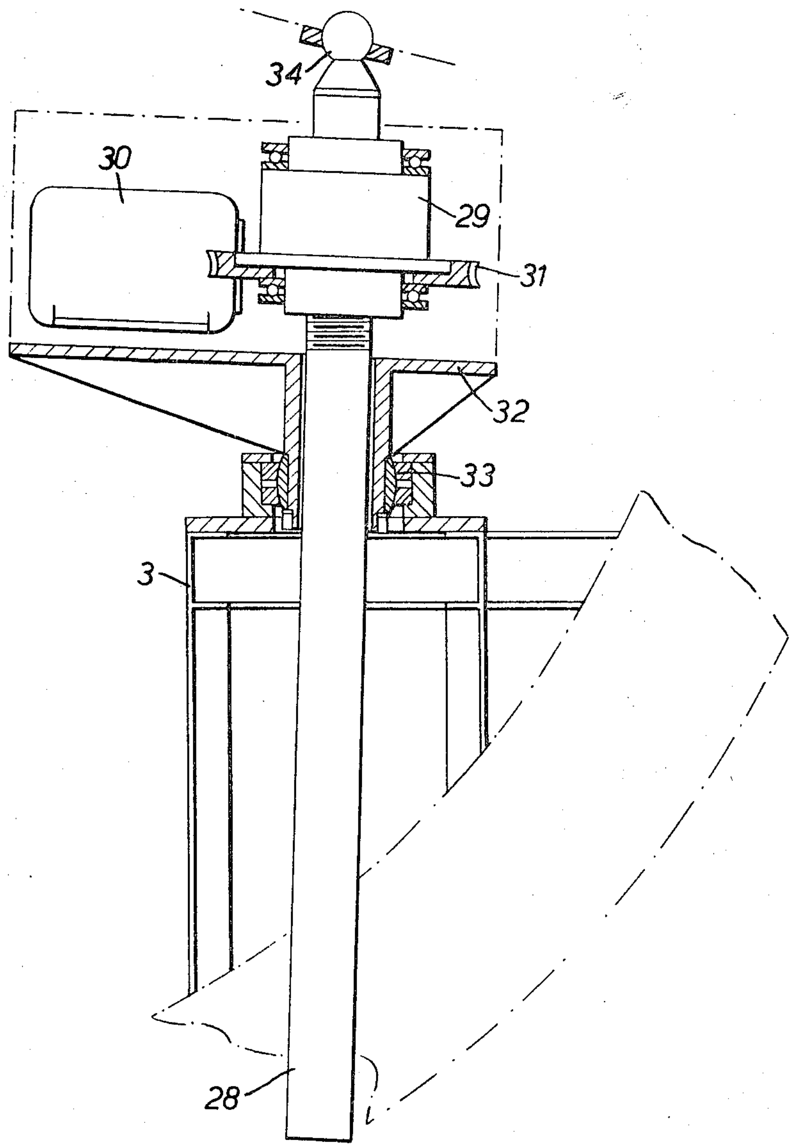

FIG. 4.

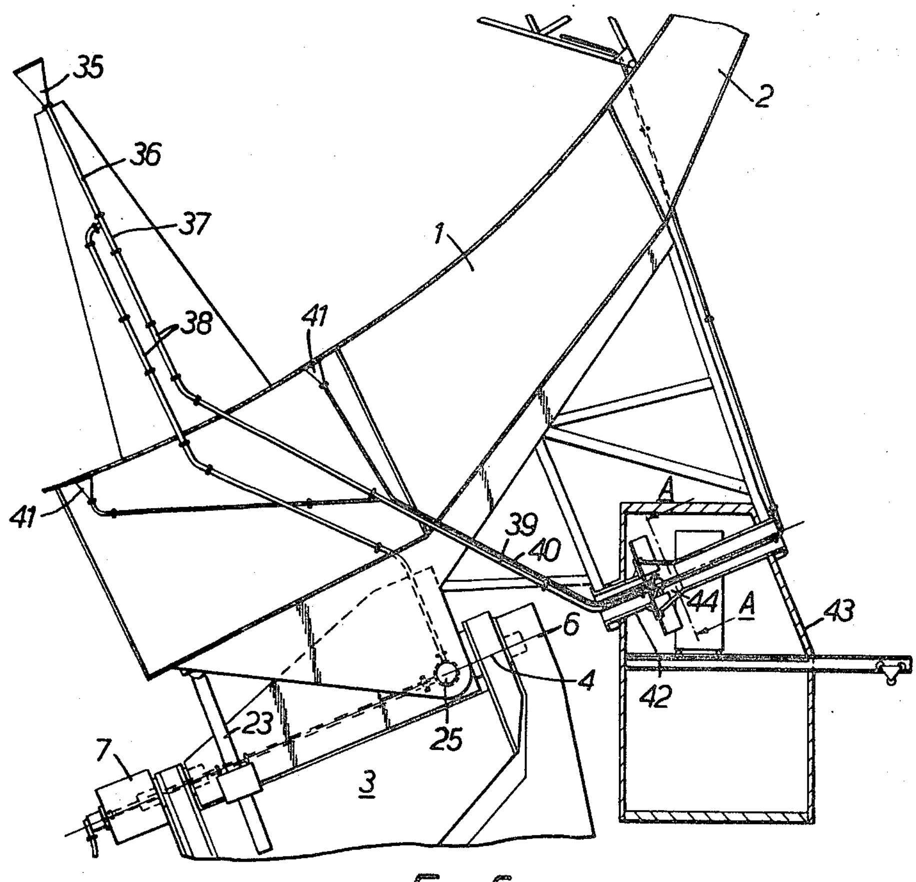

FIG. 5.

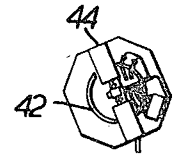

FIG. 5A

Dec. 8, 1970 R. P. SELBY ET AL 3,546,704

SATELLITE TRACKING DISK ANTENNA WITH COARSE AND FINE DRIVING MECHANISM

Filed July 28, 1967 9 Sheets-Sheet 6

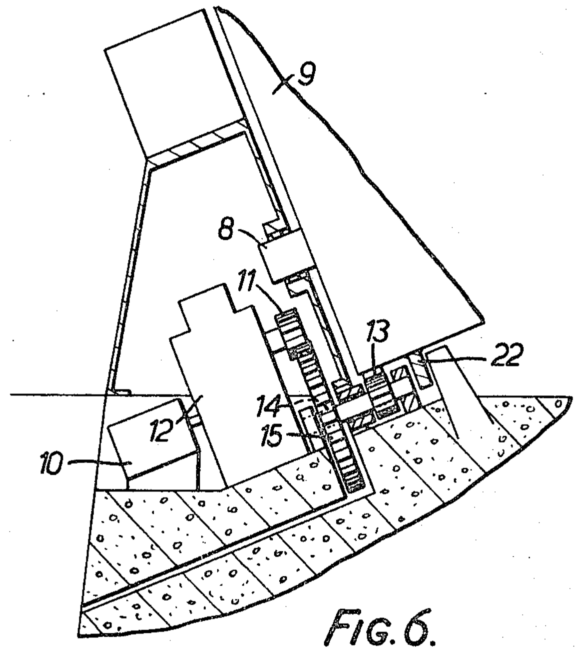

FIG. 6.

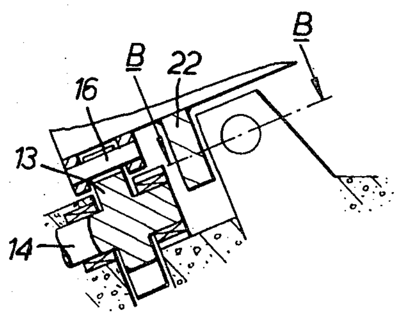

FIG. 6A.

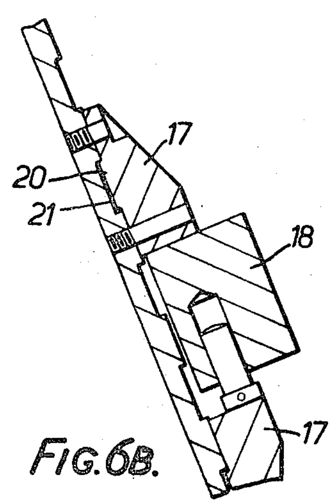

FIG. 6B.

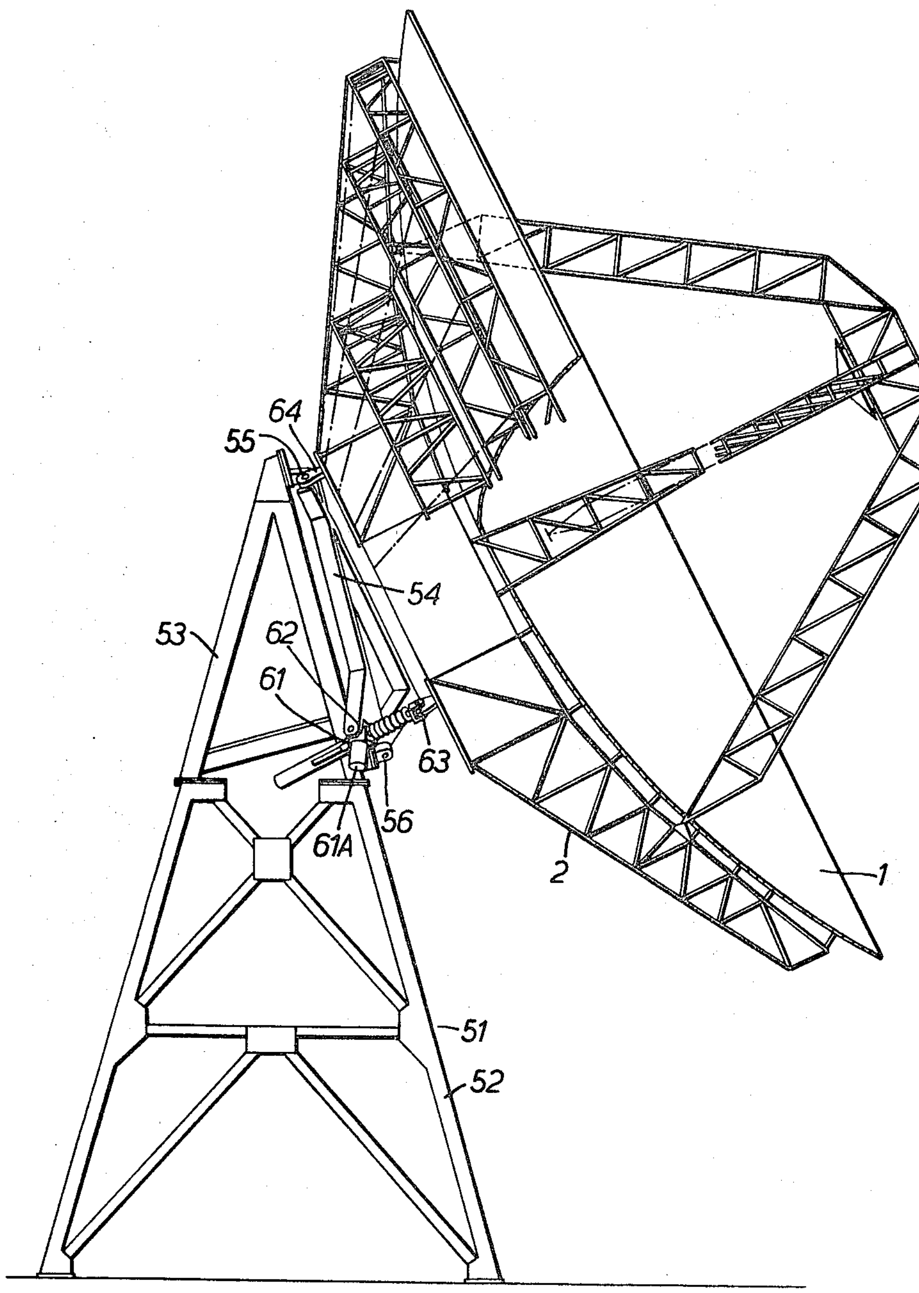

FIG. 7.

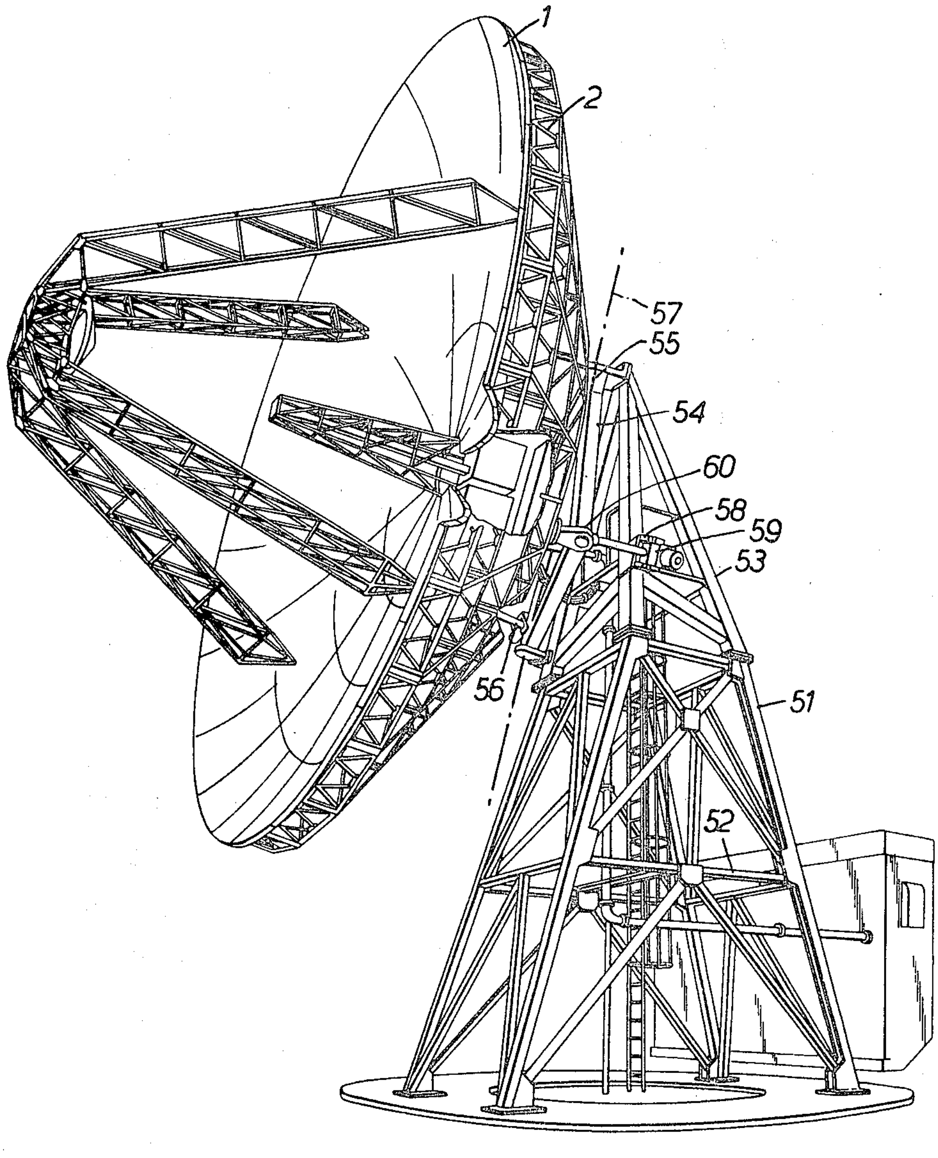

FIG. 8.

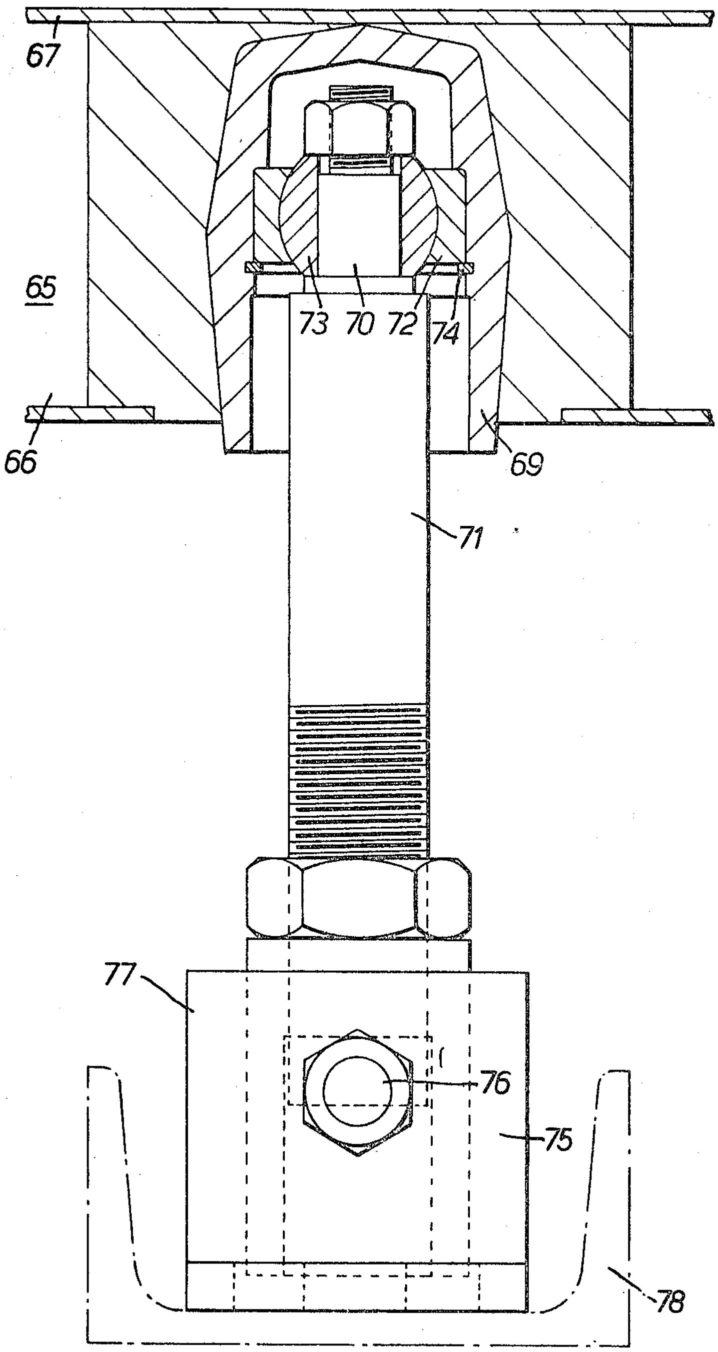

FIG. 9.

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3,546,704

SATELLITE TRACKING DISH ANTENNA WITH COURSE AND FINE DRIVING MECHANISM

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Claims priority, application Great Britain, July 29, 1966, 34,107/66
Int. Cl. H01q *3/00*
U.S. Cl. 343—765 13 Claims

ABSTRACT OF THE DISCLOSURE

A synchronous satellite tracking arrangement comprising means for producing or facilitating coarse equatorial movement of an aerial dish structure in conjunction with means for locking the dish against such movement when the focal axis of the dish intersects the satellite being tracked and means being provided for moving the dish in azimuth and elevation through a relatively small angle sufficiently large to permit the dish to track the satellite over its figure eight configuration of movement.

This invention relates to satellite tracking arrangements and relates more specifically to such arrangements for tracking so-called synchronous satellites, that is to say satellites travelling along substantially equatorial orbits and virtually stationary with respect to the earth.

For the purpose of tracking synchronous satellites a paraboloid receiving dish aerial structure may be provided which can be moved in azimuth and elevation so that the focal axis of the paraboloid dish may be lined up with the satellite which will be located at some point in an equatorial orbit. Due inter alia to slight earth wobble synchronous satellites are not completely stationary relative to the earth but in fact execute a relatively small figure eight movement configuration relative to the earth in the course of one complete revolution of the earth on its polar axis. Consequently it becomes necessary to steer the paraboloid dish in corresponding fashion in order to maintain tracking of the satellite at all times. The movement of the aerial structure in azimuth may be achieved by the provision of turning gear provided at the base of the dish aerial assembly and capable of driving the structure through 360° while the elevational movement of the aerial dish through approximately 90° say may be produced by further driving gear including quadrant gear arrangements. Quite apart from the physical size of the turning and driving gear required to produce these movements the gear needs to be substantially free from any back-lash which in turn requires the provision of precision engineered gears with the attendant disadvantage of high cost.

The present invention as broadly conceived has in view a synchronous satellite tracking arrangement in which means is provided for producing or facilitating coarse equatorial movement of an aerial dish which could for example be embodied in a radome structure, in conjunction with means for locking the dish against such movement when the focal axis of the dish intersects the satellite being tracked and means being provided for moving the dish in azimuth and elevation through a relatively small angle but which is sufficiently large to permit the dish to track the satellite over its figure eight configuration of movement previously referred to.

According to one mode of carrying out the present invention the means for facilitating coarse equatorial movement of the receiving dish may comprise rolling members which are arranged to be lowered so that the entire aerial structure is supported on the roller members. The

structure can then be rotated about a vertical axis, manually for example, to afford equatorial movement of the receiving dish so that the coarse equatorial location of the dish structure is attained for an orbiting synchronous satellite. With the dish located in such position the roller members can be raised so that the entire structure be lowered on to feet or other base engaging with the ground. The feet or base of the entire structure may then be positively secured to the ground in any convenient manner.

According to another mode of carrying out the present invention the coarse equatorial movement of the dish structure may be achieved by pivotally mounting the dish structure for pivotal movement about an axis parallel to the earth's polar axis. This coarse movement can advantageously be provided by simple and relatively cheap driving means preferably taking the form of a motor chain-driving arrangement. Once the appropriate equatorial location is achieved the dish aerial structure can be locked against further driving movement by the chain-driving arrangement, as by locking an intermediate dish mount structure to a rigid part of the tower structure. This locking may be effected by suitably contoured locking plates which are clamped by bolts to lock the intermediate mount structure to a concrete bollard for example of the tower structure. It will be appreciated that since only coarse positional adjustment of the receiving dish is required to be provided by the chain-drive before the location of the mount structure is made positive by the operation of the locking means the presence of back-lash in the chain-drive is not important.

For the purpose of providing limited azimuth and/or elevational movement of the dish aerial (say 15° movement in either direction) to take account of the restricted figure eight movement of the synchronous satellite for each revolution of the earth about its polar axis a plurality of ball screw jacking arrangements are preferably provided for turning the dish about mutually inclined axes (e.g. orthogonal axes) in response to the actuation of the ball screws. The ball screw arrangements may be motor driven through suitable reduction gearing and it will be arranged that any back-lash movement in the drive is eliminated, as by pre-loading the re-circulating balls of the ball screw arrangements.

Alternatively, the ball screw jacking arrangements could be replaced by hydraulic or pneumatic means say which also provide pivotal movement of the dish aerial in response to their actuation. To facilitate during jacking operations the movement of the ball screws or other means as appropriate in directions transverse to the direction of actuation of the ball screws said means may be gimbal mounted or otherwise afforded universal movement at points therealong, as by the provision of suitably located ball joints.

The ball screw jacking arrangements are provided between an intermediate structure and the aerial dish. In the case of the construction where the coarse azimuth movement of the dish is provided by rotation of the entire tower structure on roller members, conveniently constituted by so-called circulating roller slippers, this intermediate member may be defined by a tilt or adaptor frame pivotally mounted on the tower structure for movement about one axis and having one ball screw jacking arrangement linking the receiver dish to the tilt frame at a point on said or near said axis and the tilt frame being arranged for actuation about said axis by another ball screw jacking arrangement secured to the tower structure.

With the other arrangement in which the coarse equatorial movement of the dish aerial is provided by pivoting the dish about the polar axis two ball screw jacking arrangements may be provided at suitably spaced locations for providing movement of the aerial dish about mutually perpendicular axes, movement of the dish about one of the axes providing movement of the dish in azimuth in response to differential movement between the two ball screw jacking arrangements while movement of the dish about the mutually perpendicular axes affords elevational movement of the aerial dish.

In operation of the arrangement according to the invention movement of the ball screw jacking arrangements for affording the figure eight movement of the aerial dish will be controlled by the appropriate energisation of drive motors conveniently over feedback control loops energised in dependence upon the strength of signal received by the dish aerial. So long as the focal axis of the paraboloid aerial intersects the satellite maximum response will be obtained in the receiving equipment and the motors will both be de-energised but if the received signal should fade thereby signifying loss of tracking of the satellite one or both ball screw drive motors will be energised to drive the dish appropriately to restore tracking.

The received signal which will be received by a horn element mounted on a small tower so that element is oriented at the focus of the paraboloid dish will be arranged to travel along waveguides to receiving equipment accommodated in an operator's cabin which may conveniently be attached to the tower structure. This presents problems in the case where coarse equatorial movement of the aerial dish is achieved by pivotal movement of the dish about the polar axis since in order to avoid the cabin from being rotated to different angular positions for different equatorial settings of the dish aerial the waveguide structure would normally require to be modified considerably thereby varying the waveguide path length and this in turn almost inevitably leads to increased losses. To avoid this difficulty the present invention provides for the rotating of receiving equipment including a part of the waveguide structure within the cabin responsively to the coarse equatorial positioning of the aerial dish whilst the cabin itself remains stationary. Once the coarse movement has been completed and the locking means previously referred to rendered effective for locking the dish against further coarse movement the cabin can move with the dish in elevation but the degree of movement and the rate of such movement will be quite acceptable to an operator within the cabin. This cabin could be reached, for example, through a flexible covered passageway accommodating one or more sliding and suitably jointed access ladders.

The intermediate structure or equatorial mount structure in the last described arrangement may serve as a counter-balance weight for the dish aerial assembly as by filling the structure with concrete. The structure may be of half-conical form but the shape will of course vary in accordance with the distance of the tower from the equator and thus the trajectory of the satellite as viewed from the tower. If for example the tower were positioned on the equator then the polar axis would be horizontal and the intermediate structure could be cylindrical for example. With an inclined polar axis however the end thrust applied to a lower bearing of the intermediate equatorial mount structure may be considerably reduced by arranging that the weight is taken partly on free-running rollers carried by the rigid frame tower structure and engaging the large diameter end surface of the half-conical mount structure. It may also be advantageous to provide such rollers at the other end of the mount structure to take the load from the upper bearing under high wind force acting up the polar axis.

In the manufacture of dish aerial assemblies it is customary to construct the support or backing frame structure to rough tolerances but a reflecting surface defined by the moulded surfaces of a number of co-operating panels must be profiled with precision. The reflector surface portion of each panel may take the form of a metallised sheet carried for example by a supporting body structure conveniently of aluminum honeycomb construction. Since the reflecting surface of the dish needs to be profiled with precision while the supporting or backing structure framework is fabricated to low tolerances the attachment means for attaching the reflector panels to the backing structure should provide for the adjustment or setting of the reflector surface profile.

According to the present invention such adjustment is achieved in accordance with the invention by the provision in the reflector panels of cup-shaped inserts which are arranged for receiving universally movable parts of screw threaded attachment members which facilitate universal movement of such members when the parts are received by the cup-shaped inserts, locking means being provided to prevent withdrawal of the members from the inserts and the members threading into angularly adjustable coupling means for coupling the body panels to the backing structure. In this way, after insertion of the universally movable parts into the respective cup-shaped inserts and attachment of the angularly adjustable coupling means to frame members of the support or backing structure, the screw-threaded members can be screwed into the respective coupling means to appropriate degrees to adjust the position of the reflecting surface in relation to a template arrangement in order to provide the exact reflecting surface profile.

The universally movable part of a screw-threaded member is preferably locked within its appertaining cup-shaped insert by means of a circlip which is received by co-operating grooves in the universally movable part and the surrounding bore of the cup-shaped insert. The inserts may have machined inner cylindrical surfaces and the universally movable parts may simply comprise generally cylindrical members which are rotatable on a ball or knuckle of the screw threaded member.

In addition to or as an alternative to the circlip, the cylindrical universally movable part may be bonded to the inner bore of the cup-shaped insert.

By way of example embodiments of the present invention will now be described with reference to the accompanying drawings, in which:

FIGS. 1 and 2 are broken away diagrammatic side and rear views; respectively, of one form of synchronous satellite tracking aerial arrangement;

FIG. 3 is a pictorial perspective view of the arrangement of FIGS. 1 and 2 with parts of the arrangement being broken away to illustrate various details;

FIG. 3A is a fragmentary view of a chain driving pinion of coarse equatorial driving means of the arrangement of FIGS. 1 to 3;

FIG. 4 is a diagrammatic view of one of two ball screw jacking arrangements for fine azimuth or elevation positioning of the aerial dish;

FIG. 5 is a fragmentary view illustrating the mounting of the dish aerial and the operator's cabin;

FIG. 5A is a sectional view taken along the line A—A of FIG. 5;

FIG. 6 is a diagram showing the coarse equatorial driving means of the arrangement of FIGS. 1 to 3;

FIG. 6A is a more detailed view of the part encircled in FIG. 6;

FIG. 6B is an enlarged sectional view taken along the line B—B in FIG. 6A;

FIGS. 7 and 8 are diagrammatic elevational and pictorial perspective views, respectively, of another form of synchronous satellite tracking arrangement according to the invention; and

FIG. 9 is a diagrammatic view of an arrangement for providing fine adjustment of the reflecting surfaces of dish aerial panels.

Referring firstly to FIGS. 1 to 3 and 6 in particular the satellite tracking aerial arrangement comprises a paraboloid dish receiver aerial **1** which consists of a parabolic reflecting surface presenting body attached to a supporting or backing frame structure **2**. This dish aerial **1** is arranged to be moved so that it scans equatorially by pivotal movement of an intermediate generally half-conical equatorial mount structure **3** about an axis **4** which will be parallel to the earth's polar axis. To facilitate such pivotal movement of the structure **3** the latter may be fixedly secured to a shaft **5** (FIG. 1) which is rotatably mounted in upper and lower pedestal bearings **6** and **7**. As will be appreciated, particularly from FIG. 3, the mount structure **3** may be made solid, as for example by being filled with concrete, so that it constitutes an effective counterbalance weight for the dish aerial assembly. However, it will also be appreciated that the mass of the aerial assembly and its mount structure counter-balance weight **3** exerts considerable end thrust on the lower pedestal bearing **7**. This thrust is relieved considerably by providing free-running rollers, one of which is indicated at **8** in FIGS. 1 and 6, which bear against the lower generally semi-circular surface **9** of the mount structure **3**. These rollers thus share the end load which would otherwise be taken fully by the pedestal bearing **7**. For the purpose of rotating the conical mount structure **3** about the polar axis **4** an electric motor **10** (FIGS. 1 and 6) drives a pinion **11** through a double-worm reduction gear box **12**. The pinion **11** in turn drives a sprocket **13** fast on a shaft **14** which carries a gear wheel **15** meshing with the pinion **11**. The teeth of the sprocket **13** engage with the links of a chain secured around the large diameter end of the structure **3** as shown in FIG. 3A. Thus according to the direction of rotation of the motor **10** the mount structure **3** will be rotated by the chain drive for equatorial positioning of the dish aerial. This chain drive constitutes cheap driving means and since it is only required to drive the mount structure to provide an approximate equatorial position of the dish aerial and is then positively locked in such position any inherent slackness in the chain drive is of no consequence.

As just above mentioned the chain drive affords coarse movement of the mount structure **3**. Locking of the structure **3** is effected by bolting suitably contoured plates, as shown at **17** in FIG. 6B, to a concrete bollard **18** for example, which forms a part of the rigid support or tower structure **19** for the dish aerial. The plates **17** have projections **20** which lockingly engage in grooves **21** formed in a peripheral flange **22** of the structure **3**. Thus the plates when positioned as shown in FIG. 6B effectively lock the structure **3** to the rigid support structure **19**.

Turning now to the arrangement for producing relatively fine or restricted movement of the aerial dish **1** so that it follows the figure eight movement of the satellite relative to the earth for each revolution of the earth about is axis, the arrangement comprises a pair of ball screw jacking devices **23** and **24**, one of which is shown in some detail in FIG. 4 of the drawings. These two devices **23** and **24** are mounted towards the front of the entire aerial structure and by the actuation of these devices either singly or together the aerial dish **1** will be caused to move about bearings **25** and **26** having an axis perpendicular to the polar axis to afford elevational movement of the dish **1**. Differential movement of the ball screw jacking devices will bring about azimuth displacement of the dish **1** about axis **27**. It may be arranged in practice that the total area that can be swept by full elevational and azimuthal displacement of the dish **1** is 15° say in both directions. This is quite adequate to accommodate the figure eight movement of the satellite being tracked. Referring briefly to FIG. 4 of the drawings the ball screw device shown includes an externally threaded shaft **28** which threads into an internally threaded drive member **29** arranged to be rotated from a motor **30** through a worm driven driving gear **31**, the member **29** being fixedly secured against movement in the axial direction of the screw shaft **28** by support bearings. The motor and internally threaded member **29** together with the drive is mounted on a frame **32** which is gimbal mounted on the mount structure **3** by means of a universal joint **33**. The bottom end of the screw shaft **28** is floating but the top end is attached to the backing or support structure of the dish aerial **1** via universal ball joint **34**. The weight

of the dish structure serves for loading the ball screw device. To avoid back lash in the ball screw device which has re-circulating balls the balls are pre-loaded to take up any axial play between the screw shaft and driving member **29**. Thus the dish aerial **1** will be rigidly coupled to the tower or support structure.

In operation of the arrangement the motors appertaining to the respective ball screw jacking devices will be energised in dependence upon the response of the receiving equipment to be referred to later so that the motors by the employment of a closed loop feedback system say, keep the aerial dish located for maximum response of the receiving equipment.

Turning now to FIG. 5 of the drawings, this shows fragments of the dish aerial structure **1** and the equatorial mount structure **3** with its ball screw jacking devices and bearings. In addition FIG. 5 shows the waveguide structure for channelling received signals received from a tracked satellite to receiving equipment. This waveguide structure includes a scalar horn **35**, a circular polariser **36**, a diplexer **37** and anode suppressors **38**. As can be seen the waveguide portion **39** as well as that portion at **40** which extends from one of the two test horns **41** passes into a hollow cylindrical structure **42** which has its axis coincident with the polar axis and on which a cabin **43** is rotatably mounted or free hanging. The cabin **43** accommodates receiving equipment and part of such equipment is indicated generally at **44**. By this arrangement the dish aerial structure **1** can rotate about the polar axis **4** without producing corresponding movement of the cabin **43** since the cabin tends to maintain its vertical hanging position by rotation about the cylindrical structure **42**. The waveguide structure and receiving equipment however within the cabin **42** rotates so that there is no need for the waveguide structure to be modified for different coarse equatorial settings of the mount structure **3** and the dish aerial **1**. Consequently the waveguide can be designed for optimum efficiency which can be assured whatever the equatorial setting of the aerial might be.

Although the cabin **43** hangs freely and will not rotate during the coarse equatorial setting of the dish aerial the cabin will move in response to elevational movement of the dish structure. However, as has been mentioned previously such elevational movement will be restricted since it only results from the tracking of the satellite over its figure eight movement and since this movement is both relatively small and takes place very slowly the movement of the operator's cabin **43** is quite tolerable.

To accommodate this movement of the cabin **43** whilst affording access to it from the tower structure **19** below, the cabin has a concertina passageway **45** leading to it as shown in FIGS. 1 to 3 which accommodates sliding and suitably jointed ladders **46** affording access to the cabin from the upper compartment **47** of the tower **19**. As can best be seen in FIG. 1 of the drawings the tower **19** has other compartments **48**, **49** and **50** at different levels thereof with ladder access being provided between them and these compartments may be utilised, as appropriate, for housing various equipment the lower compartment conveniently serving as main control room. Although in the embodiment just above described the rollers, such as the roller **8**, are located at the tower end of the equatorial mount structure it is considered that corresponding rollers might advantageously be located at the top end of the mount structure to relieve upward thrust on the pedestal bearing **6** in the event of high wind force having a component acting up the polar axis. Still further the angle of the polar axis mount will clearly vary according to the position of the tracking aerial from the equator. The more this angle approaches the horizontal the greater will be the advantage of using thrust relieving rollers at both ends of the equatorial mount structure. Additionally, the shape of the mount structure **3** will be varied according to the mount's position relative to the earth's equator.

Turning now to FIGS. 7 and 8 of the drawings which show different views of another embodiment of the invention, in this embodiment the supporting tower structure for the dish aerial **1** consists of an open framework **51** having a main lower section **52** which has front and rear elevations of rectangular configuration. The frame **51** also has an upper frame portion **53** of generally triangular form. Attached to this upper frame **53** at three spaced points corresponding generally to the three apex points of the upper frame **53** is a generally triangular tilt or adaptor frame **54**. This tilt frame **54** is pivotally connected to the upper frame **53** at points **55** and **56** so that the frame **54** can pivot about an axis **57** (FIG. 8). For producing movement about the axis **57** a motor driven ball screw device **58** (FIG. 8) of the same general character as that already described with reference to FIG. 4 has the internally threaded axially restrained portion thereof anchored to the upper frame **53** at point **59** with the screw shaft of the device being attached through a ball joint to the point **60** on the tilt frame **54**. This point **60** is effectively pivotally connected to the back of the aerial support structure **2**. A second ball screw device **61** driven by motor **61A** has its internally threaded axially restrained part secured to the tilt frame **54** at **62** while the screw shaft is secured to a universal joint **63** to the aerial support structure **2**. A third universal anchor point to the structure **2** is made at the top apex **64** (FIG. 7) of the tilt frame **54**.

Referring now to the equatorial setting of the aerial structure, it will be appreciated that the tracking arrangement of the embodiment being described is suitable for tracking synchronous satellites in relatively low elevational (e.g. approximately 27° say) equatorial orbits. Thus to set the aerial to the correct equatorial setting it is only necessary to rotate the tower structure **51** about a verical axis until the particular desired equatorial setting is achieved. To this end the tower structure **51** may be provided with roller slippers (not shown) comprising circulating rollers which can be lowered as by screw jacking arrangements so that the tower is jacked up on to the roller slippers. With the tower feet or other tower base lifted clear of the ground the tower can be rotated manually for example to the appropriate angular position whereupon the feet or other base of the tower can be lowered by releasing the roller slipper jacking arrangement. The feet or base may be set in concrete for example to secure the tower in position. Thus the aerial dish may be coarsely located equatorially. For fine tracking movement of the dish the drive motors of the ball screw jacking devices **58** and **61** will be actuated as previously described in the first described embodiment in order to maintain maximum response of the receiving equipment to the signals emanating from the satellite being tracked. It is by the movement of the dish about two axes inclined to each other by 60° say corresponding to the two sides of the tilt frame that enables the dish to follow the restricted figure eight movement of the satellite being tracked.

From the foregoing it will be appreciated that the drive arrangements for the limited movement of the dish aerial are relatively simple and inexpensive to provide as against turning and driving gear for providing full movement of the dish aerial through 360° azimuth and 90° say, elevation. Since according to the invention the coarse equatorial movement is attained initially as by the rotation of the dish assembly equatorially and then the dish assembly is locked against further coarse movement, the driving means for the equatorial mount structure or the means (i.e. slipper rollers) facilitating equatorial movement, as the use may be, can be of cheap and simple construction thus leading to very significant savings in cost.

It is especially contemplated that dish sizes for the two tracking arrangements described may be 85 feet and 45 feet diameter respectively, but these sizes may clearly be varied.

It has previously been mentioned that the invention also provides an arrangement for adjusting the profile of the reflecting surface of a dish aerial. This reflecting surface may be made up from a number of panels which are secured to the backing or support framework of a dish aerial structure. By reason of the fact that the support framework is fabricated to rough tolerances the means for attaching the panels to the framework desirably embody some means for universal positional adjustment of the reflecting surfaces of the panels. FIG. 9 shows suitable attachment means for this purpose.

Referring then to FIG. 9, a fragment of one of the reflector panels is indicated at **65**. This panel includes a support body **66** of aluminum honeycomb construction to which is attached a reflecting surface in the form of a thin sheet **67** of metallised material. Set as by epoxy resin **68** in cavities of the body, only one of which is shown in the figure, are a plurality of metal (e.g. aluminum) cup-shaped members one of which is indicated at **69**. Each of these cup-shaped members is machined on its inner periphery to provide a stepped and grooved bore as can be seen in the figure. This is to provide for the reception of a universal joint structure **70** provided at one end of a screw threaded tie member **71**. The structure **70** includes a generally annular member **72** which swivels on a ball **73**. The member **72** is locked in the bore of the member **69** to prevent its withdrawal by means of a circlip **74** which is accommodated in radially aligned grooves of the members **69** and **72**.

The lower end of the tie bolt **71** threads into a tapped swivel block **75** which can swivel about a bolt **76** that passes through an upstanding flange **77** of a generally channel-shaped bracket **78**. The bracket **78** is for attachment to one of the frame members of the supporting or backing structure.

In use of the profile adjusting means a panel having say four tie bolts attached to it will be coupled up to frame members of the backing structure through the respective angularly adjustable swivel block and bracket coupling means. The tie bolts will then be tightened to draw the reflecting surface of the panel into the desired position relative to the reflecting surfaces of adjacent panels and to define a reflecting surface profile determined by a template used in conjunction with the attachment means. When the desired reflecting surface profile is achieved the swivel block and bracket may be welded together in their final relative angular positions while the effective length of the tie bolt may be fixed. In this way the profile of the reflecting surface is in effect pre-set. If desired the outer periphery of the annular member **72** could be bonded to the bore of the cup-shaped insert **69**.

What we claim is:

1. A synchronous satellite tracking arrangement comprising means for producting or facilitating coarse equatorial movement of an aerial dish structure in conjunction with means for locking the dish against such movement when the focal axis of the dish intersects the satellite being tracked, and means for moving the dish in azimuth and elevation through a relatively small angle sufficiently large to permit the dish to track the satellite over its figure eight configuration of movement, in which the coarse equatorial movement of the dish structure is provided for by mounting the dish structure for pivotal movement about an axis parallel to the earth's polar axis and providing associated driving means.

2. A satellite tracking arrangement as claimed in claim **1**, comprising an operator's cabin pivotally attached to the aerial dish structure, signal receiving equipment mounted within said cabin, waveguide means connected with said equipment and said aerial, in which said equipment and waveguide moves in response to movement of the dish structure about the polar axis whilst the cabin remains stationary.

3. A satellite tracking arrangement as claimed in claim 1, in which the associated driving means comprises a motor chain-driving arrangement.

4. A satellite tracking arrangement as claimed in claim 3, which includes an intermediate dish mount structure, a tower structure, and means for locking the intermediate dish mount structure to said tower structure to prevent further driving movement of the dish structure by the chain-driving arrangement once the appropriate equitorial location of the dish structure is achieved.

5. A satellite tracking arrangement as claimed in claim 4, in which locking is effected by suitably contoured locking plates which are clamped by bolts to lock the intermediate dish mount structure to a bollard of the tower structure.

6. A satellite tracking arrangement as claimed in claim 4, in which the intermediate dish mount structure serves as a counterbalance weight for the dish aerial assembly.

7. A satellite tracking arrangement as claimed in claim 6, in which the mount structure is of half-conical form and has its axis parallel to the polar axis and in which the end thrust applied to a lower bearing of the intermediate mount structure is reduced by arranging that the weight of the structure is taken partly on free running rollers carried by the tower structure and engaging the large diameter end surface of the half conical mount structure.

8. A satellite tracking arrangement as claimed in claim 4, in which free running rollers are provided at both ends of the mount structure.

9. A synchronous satellite tracking arrangement comprising means for producing or fasicilating coarse equatorial movement of an aerial dish structure in conjunction with means for locking the dish against such movement when the focal axis of the dish intersects the satellite being tracked, and means for moving the dish in azimuth and elevation through a relatively small angle sufficiently large to permit the dish to track the satellite over its figure eight configuration of movement, in which limited azimuth and/or elevational movement of the dish aerial structure to take account of the restricted figure eight movement of the synchronous satellite for each revolution of the earth about its polar axis is provided by the appropriate actuation of ball screw jacking arrangements for turning the dish about mutually inclined (e.g. perpendicular) axes in response to the actuation of the ball screws.

10. A satellite tracking arrangement as claimed in claim 9, in which the ball screw arrangements are motor driven through suitable reduction gearing and backlash movement in the drive is eliminated by pre-loading recirculating balls of the ball screw arrangements.

11. A satellite tracking arrangement as claimed in claim 9, in which the ball screw jacking arrangements are gimbal mounted.

12. A satellite tracking arrangement as claimed in claim 9, in which the ball screw jacking arrangements are provided between an intermediate structure and the aerial dish, the intermediate member being constituted by a tilt or adapter frame pivotally mounted on a tower structure for movement about one axis and having one ball screw jacking arrangement linking the receiver dish to the tilt frame at a point on said or near said axis and the tilt frame being arranged for actuation about said axis by another ball screw jacking arrangement secured to the tower structure.

13. A satellite tracking arrangement as claimed in claim 9, in which two ball screw jacking arrangements are provided at suitably spaced locations for providing movement of the aerial dish about mutually perpendicular axes, movement of the dish about one of the axes providing movement of the dish in azimuth in response to differential movement between the two ball screw jacking arrangements while movement of the dish about the mutually perpendicular axes affords elevational movement of the aerail dish.

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