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3,440,659

TOWER SUPPORTED MICROWAVE REFLECTOR WITH ADJUSTABLE MOUNT

Filed Jan. 24, 1966

Sheet / of 2

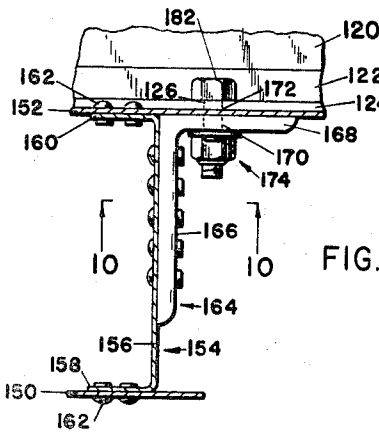


FIG. 9

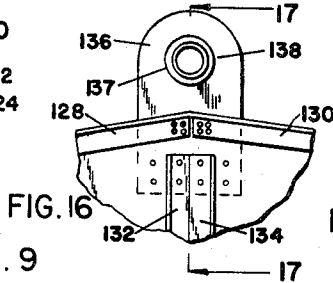


FIG. 16

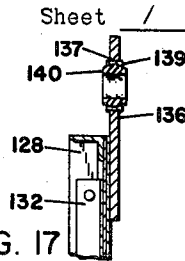


FIG. 17

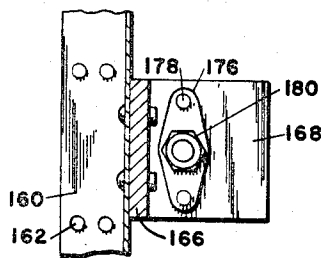


FIG. 10

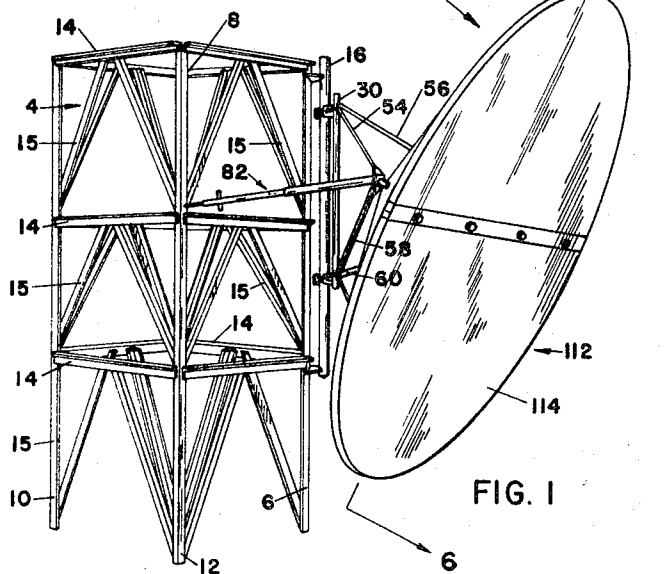


FIG. 1

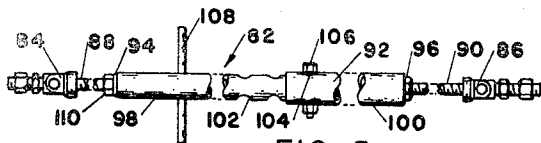


FIG. 5

FIG. 13

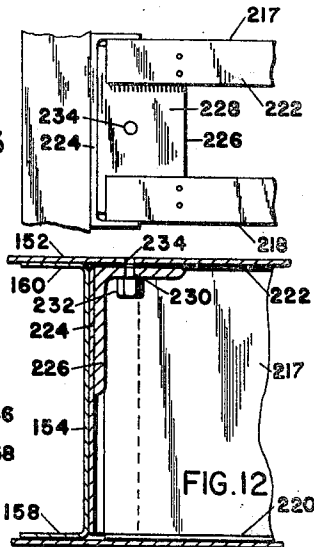


FIG. 12

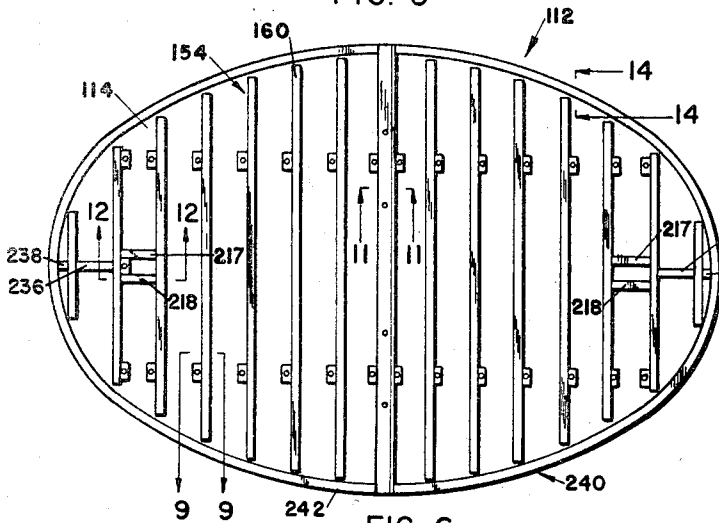


FIG. 6

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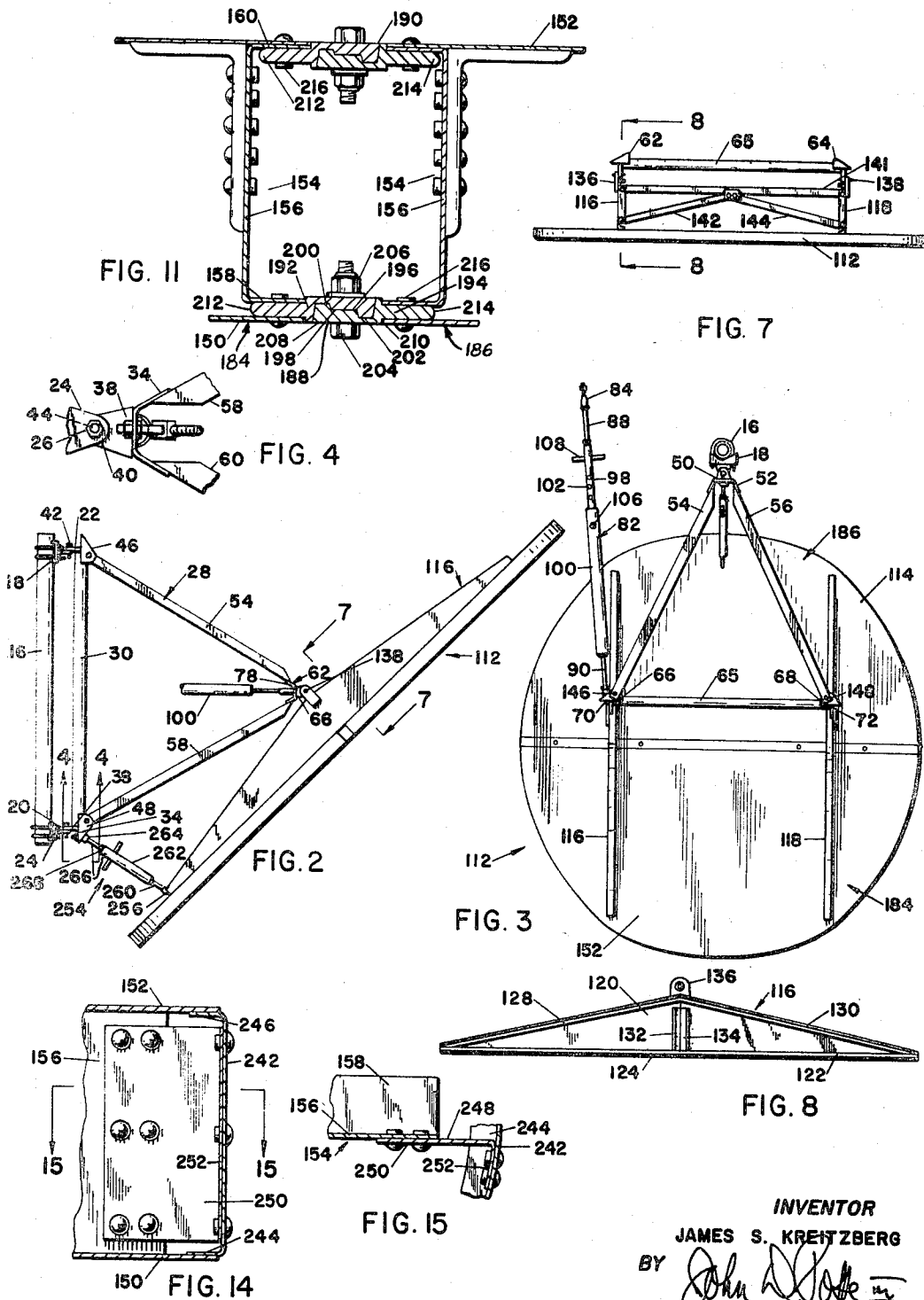
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Sheet 2 of 2



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TOWER SUPPORTED MICROWAVE REFLECTOR WITH ADJUSTABLE MOUNT

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10 Claims

ABSTRACT OF THE DISCLOSURE

A microwave reflector assembly adapted for installation on a rigid support includes an elliptical reflector disk optionally separable into halves on a mounting frame. The mounting frame is attached to the rigid support and includes a horizontal member adjacent the horizontal axis, and two pairs of supporting members connecting the horizontal member to the rigid support. One pair of supporting members extends from one location on the support to opposite ends of the horizontal member while the other pair of supporting members extends from another location on the support to the opposite ends of the horizontal member. This provides a gimbal support. Separate adjusting means alter the azimuth and elevation relation of the frame to the support. Spars are hinged to the mounting frame and there are ribs between the face and back skin of the disk. The gimbal mounting supports the weight of the reflector assembly without substantial aid from either adjusting means.

This invention relates in general to microwave reflectors and, more particularly, to microwave reflector assemblies adapted for use in so-called periscope systems.

Microwave systems have become increasingly popular in recent years, not only with large telephone companies, but also with various other unrelated industries which have found it convenient as well as economical to establish independent communication systems between their various operations situated at different geographical locations. Microwave communication systems, of course, do not utilize land lines to any great extent and can, therefore, traverse impassable terrain. Moreover, they are more economical to maintain and require an initial investment which is considerably less in magnitude than conventional land lines.

In so-called periscope systems, microwaves are generated at ground level and generally beamed upwardly to a reflector located high above the ground where they are intercepted and reflected laterally over the earth's surface to a microwave antenna, relay station, or another reflector. In any event the reflector and the device to which it is beamed must be located at a sufficient height above the ground to avoid interference from such intermediate objects as buildings, trees, hills, and the like. For this reason, it is desirable to locate the reflector high above the ground, preferably on a tower, with the reflecting surface located at approximately 45° to the horizontal.

Such reflectors, to operate satisfactorily, must have substantially flat rigidly mounted reflecting surfaces which will not buckle, bend or otherwise become distorted when subjected to wind and ice loading and to extremes in temperature. Moreover, the reflector must have means for permitting precise adjustment of the reflecting surface once the reflector assembly is installed on the tower.

The present invention relates to a microwave reflector assembly provided with a rigidly mounted flat reflecting surface having an elliptical shape and incorporating means for precisely adjusting the elevation or tilt and azimuth or horizontal angle of such surface.

Among the several objects of the present invention may be noted the provision of a microwave reflector assembly having a flat reflecting surface which will not distort when subjected to wind and ice loading and to extremes in temperature; the provision of a reflector assembly of the type stated having means for providing precise adjustment of the reflecting surface along both vertical and horizontal axes; the provision of a reflector assembly which is simple and rugged in construction and easy to manufacture; the provision of a reflector assembly of the type stated which can be easily crated and shipped in disassembled condition and thereafter readily assembled at the point of use; the provision of a reflector assembly having a reflector which readily sheds snow and rain water; and the provision of a reflector assembly which substantially eliminates second Fresnel zone effects. Other objects and features will be in part apparent and in part pointed out hereinafter.

The invention accordingly comprises the constructions hereinafter described, the scope of the invention being indicated in the following claims.

In the accompanying drawings, in which one of various possible embodiments of the invention is illustrated,

FIG. 1 is a perspective view of a reflector assembly constructed in accordance with and embodying the present invention, the reflector assembly being mounted on a supporting tower;

FIG. 2 is a side elevational view of the reflector assembly;

FIG. 3 is a top plan view of the reflector assembly;

FIG. 4 is a sectional view taken along line 4—4 of FIG. 2;

FIG. 5 is a segmented elevational view of an adjusting rod forming part of the present invention;

FIG. 6 is a sectional view taken along line 6—6 of FIG. 1;

FIG. 7 is a sectional view taken along line 7—7 of FIG. 2;

FIG. 8 is a sectional view taken along line 8—8 of FIG. 7;

FIG. 9 is a sectional view taken along line 9—9 of FIG. 6;

FIG. 10 is a sectional view taken along line 10—10 of FIG. 9;

FIGS. 11 and 12 are sectional views taken along lines 11—11 and 12—12, respectively, of FIG. 6;

FIG. 13 is an enlarged plan view of the rib construction shown in FIG. 12;

FIG. 14 is a sectional view taken along line 14—14 of FIG. 6;

FIG. 15 is a sectional view taken along line 15—15 of FIG. 14;

FIG. 16 is an elevational view of a reflector mounting tab forming part of the present invention; and

FIG. 17 is a sectional view taken along line 17—17 of FIG. 16.

Corresponding reference characters indicate corresponding parts throughout the several views of the drawings.

Referring now in more detail and by reference characters to the drawings, which illustrate a preferred embodiment of the present invention, 2 designates a microwave reflector assembly which is mounted on an antenna or other suitable tower 4. Tower 4 is conventional in design and construction and it is, therefore, sufficient for purposes of the present disclosure to note that it includes four corner uprights 6, 8, 10, 12, which are transversely connected at spaced intervals by cross-members 14. Diagonally connecting cross-members 14 and corner uprights 6, 8, 10, 12, are gusset members 15. Rigidly bolted or otherwise secured to cross-members 14 in slightly outwardly spaced relation from corner upright 6 and located at a substantial height above the ground is vertically extending support pipe 16 which spans several cross-

members 14. Support pipe 16 is a standard accessory found on microwave antenna towers for mounting antennas thereon. Fastened to support pipe 16 by U-bolts or other suitable means are support brackets 18, 20, having outwardly projecting horizontally presented tabs 22, 24, provided with axially aligned apertures 26.

Hingedly carried by brackets 18, 20, is reflector assembly 2 including a mounting frame 28 provided on its one side with a vertical pipe-like member 30 having hinge brackets 32, 34, welded or otherwise rigidly secured to its ends. Hinge brackets 32, 34, include outwardly projecting horizontal tabs 36, 38, respectively, presented in overlying relation to tabs 22, 24, respectively, of support brackets 18, 20, tabs 36, 38, being provided with axially aligned apertures 40 which register with apertures 26 of tabs 22, 24. Fitted through apertures 26, 40, are bolts 42, 44, which, in effect, serve as hinge pins for mounting frame 28. Hinge brackets 32, 34, further include wing-like members 46, 48, respectively, each having a downwardly projecting center portion 50 which merges into forwardly protruding angulated ears 52. Bolted or otherwise suitably secured to ears 52 of upper wing-like member 46 are forwardly diverging upper frame members 54, 56, which converge with forwardly diverging lower frame members 58, 60, the latter being secured at their rearwardly presented ends to ears 52 of the lower wing-like member 48. As will be seen by reference to FIG. 4, the forwardly presented ends of frame members 54, 58, and 56, 60, are located in close proximity to one another where they are bolted to hinge brackets 62, 64, which are welded or otherwise secured to the ends of a horizontal cross pipe 65. Brackets 62, 64, are identical to brackets 32, 34, and, similarly, include forwardly projecting tabs 66, 68, respectively, and wing-like members 70, 72, respectively, the former of which are provided with axially aligned apertures 74 while each of the latter include an axially projecting center portion 76 which merges into angulated ears 78. Ears 78 of bracket 62 are respectively bolted or otherwise rigidly fastened to the opposite ends of upper and lower frame members 54, 58, and, similarly, ears 78 of bracket 64 are joined to the opposite ends of upper and lower frame members 56, 60.

Interconnecting hinge bracket 62 and upright 8 of tower 4 is a horizontally presented azimuth adjusting rod 82. More particularly, azimuth adjusting rod 82, as will be seen by reference to FIG. 5, is provided at its ends with pivotal clevis fittings 84, 86, which are bolted respectively to upright 8 of tower 4 and axially projecting center portion 76 of wing-like member 70 forming part of hinge bracket 62. Rigidly fastened to clevis fittings 84, 86, are threaded shanks 88, 90, having right and left hand threads respectively. Interposed between threaded shanks 88, 90, is a telescopic sleeve 92 having threaded bushings 94, 96, rigidly fastened in its ends, which bushings engage the threads of shanks 88, 90. Sleeve 92 comprises a sleeve half 98 which telescopically fits within a diametrically larger sleeve half 100 so that the effective length of sleeve 92 can be varied. Sleeve half 98 is provided with a plurality of longitudinally spaced diametrically extending holes 102 which are adapted to register with diametrically opposed apertures 104 located in the cylindrical wall of sleeve half 100. Adapted for insertion through aligned apertures 104 and a preselected hole 102 is a lock bolt 106. Thus, sleeve 92 can be extended or shortened until a desired length is reached whereupon apertures 104 are brought into registration with the nearest hole 102 and lock bolt 106 is fitted therethrough. Further adjustment is obtained by rotating sleeve 92 which causes threaded shanks 88, 90, to move inwardly or outwardly from the reversely threaded bushings 94, 96. To facilitate rotation of sleeve 92, sleeve half 98 is provided in close proximity to bushing 94 with radially projecting arms 108 which can be manually grasped and rotated. Threadedly mounted on shank 88 intermediate

clevis fitting 84 and bushing 94 is a lock nut 110 which is run up tightly against bushing 94 after the desired azimuth setting is obtained so as to hold that setting indefinitely or until another setting is desired. Of course, the horizontal angle of mounting frame 28 about its axis defined by vertically aligned apertures 26, 40, is dependent on the particular setting of azimuth adjusting rod 82.

Hingedly mounted on hinge brackets 62, 64, is a reflector 112 including an elliptical reflector disk 114 of monocoque construction and supporting spars 116, 118, securely fastened to the rear face thereof. Inasmuch as spars 116, 118, are identical in design and construction only spar 116 will be described in detail herein. Spar 116 includes a side plate 120 shaped in the configuration of an isosceles triangle and having an angle member 122 riveted or otherwise securely fastened along the inwardly presented face thereof, angle 122 having a perpendicularly projecting flange 124 located in juxtaposition to the bottom margin of side plate 120. Flange 124 is provided with a plurality of spaced apertures 126. Riveted or otherwise securely fastened to side plate 120 along its upper or leg-forming margins are angles 128, 130, and similarly along its centerline it is provided with opposed angles 132, 134, for lending rigidity thereto. Similarly secured to the opposite face of side plate 120 and projecting outwardly beyond the apex thereof is a mounting tab 136 provided with an aperture 137. Snugly fitted within aperture 137, as best seen in FIGS. 16 and 17, is a self-aligning bearing 138, including an annular outer race 139 which is press-fitted or otherwise tightly inserted in aperture 137. The inwardly presented face of race 139 is concaved and rotatably accepts an axially protruding annular inner race 140 having a convexed outer face which is contoured to conform with the contour of the concaved face of outer race 139. The radii of the complementary concaved and convexed surfaces originate at the center of bearing 138, thus enabling the inner race 140 to swivel slightly within the outer race 139, as well as to rotate therein. Bearings 138 register with apertures 74 of tabs 66, 68, forming part of hinge brackets 62, 64. Riveted to angles 132, 134, and transversely connecting spars 116, 118, is a spacer member 141 and further interconnecting spacer member 141 and angles 132, 134, of spars 116, 118, are diagonally extending braces 142, 144, which lend rigidity to the structure, all as best seen in FIG. 7. Snugly fitted within apertures 74 of tabs 66, 68, and in the juxtaposed self-aligning bearing 138 of spars 116, 118, are bolts 146, 148, which in effect form hinge pins which support reflector 112. In other words, bolts 146, 148, form the horizontal axis about which reflector 112 rotates. Moreover, when bolts 146, 148, are drawn up tight, the axially protruding portions of inner race 140 of self-aligning bearing 138 will be drawn up tightly against the outwardly presented faces of tabs 66, 68, but reflector 112 will nevertheless be free to rotate on bearing 138.

Referring now to FIGS. 6 through 15, elliptical reflector disk 114 is provided with spaced parallel face and back skins 150, 152, respectively, which are preferably formed from relatively narrow gauge sheet steel. Internally disk 114 is provided at spaced intervals with a plurality of transversely extending parallel ribs 154 which maintain the skins 150, 152, in parallel spaced relation to one another. Each of ribs 154 has a channel-like cross-sectional shape formed by a center portion 156 which integrally merges into front and rear flanges 158, 160, against which face skin 150 and back skin 152 are held, respectively, by means of rivets 162. As will be seen by reference to FIG. 6, ribs 154 are of varying length so as to conform to the elliptical shape of disk 114. Of course, when manufacturing larger types of reflector disks 114, it may be desirable to fabricate face and back skins 150, 152, from a plurality of transversely extending strips having abutting side margins which are presented over

flanges 158, 160, of ribs 154. In such an instance, the number of sheets could conceivably equal the number of spaces located between ribs 154.

On each side of its longitudinal centerline along lines equally spaced therefrom and parallel thereto, reflector disk 114 is internally provided with a plurality of L-shaped brackets 164 each having a side flange 166 and a top flange 168 presented perpendicularly to one another, as best seen in FIG. 9. Side flange 166 is riveted to center portion 156 of rib 154 with the outwardly presented surface of top flange 168 presented in underlying abutment with back skin 152. Top flange 168 is provided with a circular aperture 170 located in registration with a similar aperture 172 formed in back skin 152, both apertures 170, 172, being in registration with apertures 126 in angles 122 forming part of spars 116, 118. Rigidly held to the inwardly presented face of top flange 168 is a captive nut 174 including an elongated base 176 which is fastened to flange 168 by means of countersunk rivets 178. Securely fastened to elongated base 176 in registration with apertures 170, 172, is an elastic or other suitable self-locking nut 180. Fitted through apertures 126 of spars 116, 118, and apertures 170, 172, are cap screws 182 which engage the threads of captive nut 174 whereby spars 116, 118, are fastened securely to elliptical disk 114 in rearwardly projecting perpendicular relation to the back skin thereof and in parallel relation to one another.

Referring now to FIG. 11, reflector disk 114 is bisected into disk halves 184, 186, at transversely extending joints 188, 190, which are preferably extruded from a suitable metal such as aluminum. Inasmuch as joints 188, 190, are formed from identical extrusions only joint 188 will be described presently in detail. Joint 188 includes detachable joint elements 192, 194, having mortised locking portions 196, 198, provided with complementary interlocking faces 200, 202, which engage one another and prevent lateral separation of joint elements 192, 194. Complementary interlocking faces 200, 202, are held in facewise abutment by means of bolts 204 which extend through locking portions 196, 198, and engage captive nuts 206 secured to the inwardly presented face of locking portion 196. Locking portions 196, 198, laterally terminate at longitudinal shoulders 208, 210, where they integrally merge into wing-like side portions 212, 214, which are interposed between face skin 150 of disk halves 184, 186, respectively, and front flanges 158 of the first ribs 154 located on each side of joint 188, flanges 158, face skin 150 and side portions 212, 214, being held securely together by rivets 216. In this connection, it should be noted that center portions 156 of the first ribs 154 are somewhat narrower than center portions 156 of the remaining ribs 154 by a distance equal to the thickness of wing-like side portions 212, 214. Moreover, joint elements 192, 194, are preferably extrusions of identical cross-sectional shape, elements 192, 194, being fastened to disk halves 184, 186, in reverse relation to one another so that interlocking faces 200, 202, engage one another.

It has already been noted that joint 190 is identical to joint 188. Nevertheless, it is important to note that rear flanges 160 of the first ribs 154 extend over the outwardly presented face of wing-like side portions 212, 214, thereof where they are held in place along with back skin 152 by means of rivets 216. Moreover, joints 188, 190, are fastened to disk halves 184, 186, so that complementary interlocking faces 200, 202, can be drawn apart when bolts 204 are removed. Thus, reflector disk 114 can be readily separated into disk halves 184, 186, for convenience of crating, shipping and storage. Of course, when reflector 112 is fully assembled spars 116, 118, lend reinforcement to joints 188, 190, and aid in maintaining true and correct alignment between respective face skins 150 of reflector halves 184, 186, by providing a planar face against which back skin 152 and ribs 154 are rigidly supported.

As will be seen by reference to FIGS. 6, 12, and 13, disk half 184 is internally provided intermediate two of its outer ribs 154 with closely spaced parallel rib sections 217, 218, each having front and rear flanges 220, 222, which are riveted to face and back skins 150, 152, respectively, and an end flange 224 which is riveted to center portion 156 of the outer of the two ribs 154. Rigidly riveted to center portion 156 to the same rib 154 intermediate rib sections 217, 218, is an L-shaped bracket 226 having an outer flange 228 located in juxtaposition to the inwardly presented face of back skin 152. Flange 228 is provided with an aperture 230 and a captive nut 232 rigidly fastened to the inwardly presented face thereof in surrounding relation to aperture 230. Moreover, back skin 152 is provided with an aperture 234 which registers with aperture 230.

Riveted to face and back skins 150, 152, between two outermost ribs 154 of disk halves 184, 186, along the longitudinal centerline of reflector disk 114 are reinforcing rib sections 236 which are similar to rib sections 217, 218, and similarly projecting beyond end ribs 154 in colinear relation to rib sections 236 are end rib sections 238.

The peripheral edge of reflector disk 114 is sealed by a rim 240 having a center portion 242 which forms the lateral edge of reflector disk 114, as best seen in FIGS. 14 and 15. Center portion 242 integrally merges into inwardly projecting flanges 244, 246, which engage the inwardly presented surfaces of face skin 150 and back skin 152, respectively. Rim 240 is securely held in position by means of angulated connecting members 248 which project beyond the ends of ribs 154, connecting members 248 having shanks 250 which are riveted to center portions 156 of ribs 154. Shanks 250 integrally merge into flanges 252 which are arcuately bent to match the contour of center portion 242 of rim 240 to which they are securely fastened preferably by means of rivets. Of course, rim 240 is interrupted at joints 188, 190, so that disk halves 184, 186, can be separated.

Interposed between reflector disk 114 and mounting frame 28 is an elevation adjusting rod 254 which is very similar in construction to azimuth adjusting rod 82. It is, therefore, sufficient for the purposes of the present disclosure to note that elevation adjusting rod 254 includes a pivotal clevis fitting 256 having a threaded end portion 258 which fits through aperture 234 in back skin 152 and aperture 230 in L-shaped bracket 226 beyond which it engages the threads of captive nut 232. Clevis fitting 256 is fitted with a threaded shank 260 which threadedly engages one end of a telescopic sleeve 262. At its opposite end, adjusting rod 254 is provided with a pivotal clevis fitting 264 which is rigidly bolted to the downwardly projecting center portion 50 of wing-like member 48 forming part of bracket 34. Projecting from clevis fitting 264 is a threaded shank 266 which threadedly engages the opposite end of sleeve 262. Of course, the threads of threaded shanks 260, 266, are spiraled opposite to one another so that adjusting rod 254 will extend or retract depending on the direction in which sleeve 262 is rotated. Greater extensions or retractions can be obtained by altering the telescopic relation between the halves of sleeve 262. Threaded shank 266 carries a lock nut 268 which is run up against the end of sleeve 262 for holding the same in rigid non-rotatable position with respect to shanks 260, 266. By reference to FIG. 2, it is evident that the angular relation of reflector disk 114 with respect to the horizontal is dependent on the length or adjustment of elevation adjusting rod 254.

It should be noted that it is desirable to fit clevis fittings 84, 86, 256, 264, with self-aligning bearings constructed similar to bearings 138 of reflector 112 to prevent binding and yet reduce backlash.

In use, microwave reflector assembly 2 is located on tower 4 immediately above a microwave transmitting and receiving unit (not shown). Transmissions in the nature

of microwaves are generated by the unit and beamed upwardly to reflector 112 which intercepts such microwaves and beams them laterally over the earth's surface toward a distant receiving antenna, relay station, or another reflector. By rotating sleeves 92, 262, of adjusting rods 82, 254, respectively, precise elevational and azimuth settings can be imparted to reflector 112 so that it can be beamed directly at a particular antenna, relay station, or reflector. Inasmuch as adjusting rods 82, 254, support very little, if any, load they are extremely easy to manipulate and to do so requires no specialized tools. In this connection, it should be noted that bolts 146, 148, which form the horizontal axis about which reflector 112 rotates need not be loosened for the reflector rotates freely about self-aligning bearings 138. Furthermore, the azimuth and elevation settings are independent of one another so that one can be changed without disturbing the other. The telescopic construction of sleeves 92, 262, of adjusting rods 82, 254, allows a wide range of fine adjustment without utilizing spacers, brackets, and the like. Once a correct setting is obtained reflector 112 can be rigidly locked in the correct position merely by tightening lock nuts 110, 268, against sleeves 92, 262. When locked in position, reflector 112 will remain rigidly in that position making it ideally suited for use with high frequency microwave transmission systems. The backlash in self-aligning bearings 138 and in clevis fittings 84, 86, 256, 264, is very small and reflectors manufactured according to the teachings hereof will move less than one-tenth degree relative to the tower even under wind and ice load conditions.

The monocoque constructed of reflector disk 114 provides an extremely high degree of rigidity to the entire reflector 112 in relation to the weight thereof and, more important, maintains face skin 150 in a planar condition. In this connection, it should be noted that after installation on tower 4 and when not subjected to outside forces, the outer surface of face skin 150 should be perfectly flat, but concavity amounting to no more than $\frac{1}{8}$ inch is permissible. The maximum deflection of the outer surface of face skin 150 when subjected to wind and ice loading must not be greater than $\frac{1}{8}$ inch toward concavity or convexity. Spars 116, 118, provide a rigid back-up structure for reflector disk 114 and further aid in maintaining a perfectly flat or planar reflector surface on face skin 150. The design of spars 116, 118, permits fabrication of such with an accurately controlled straight edge which is bolted to back skin 152 and ribs 154 at closely spaced intervals along reflector disk 114 by means of cap screws 182. The smooth outer surface of back skin 152 has no transversely extending webs or the like which are susceptible of collecting snow and ice. On the contrary, the smooth back skin 152 readily sheds snow and water and thereby retards ice build-up which, of course, would create additional forces having a tendency to disturb the precise azimuth and elevational settings of reflector 112. Moreover, whatever ice or snow does build up on disk 114 is not against facing skin 150 and continual freezing and thawing cannot thereby distort the reflecting face.

The elliptical shape of disk 114 reduces the weight of the entire reflector 112 and further reduces wind loading by eliminating corners which are not effective as a reflecting surface. Moreover, the elimination of corners presents less area for ice and snow buildup. Furthermore, the elliptical shape provides maximum reflector efficiency by eliminating second Fresnel zone effects.

The entire microwave reflector assembly 2 can be broken down into several sub-components for convenient crating, transporting and storage. Inasmuch as some of the reflector disks 114 can be as large as 12 feet by 17 feet, this is a decided advantage. Of course, disk 114 is reducible into disk halves 184, 186, and this can be accomplished merely by withdrawing cap screws 182 and removing spars 116, 118, from the back of disk 114. After removing bolts 204 complementary interlocking faces 200, 202, of joints 188, 190, can be separated and disk half 184 can be laterally separated from disk half

186. Of course, reflector 112 can be readily assembled in the field by reversing the above steps, in which case joint elements 188, 190, and spars 116, 118, assure perfect alignment of disk halves 184, 186, and return to the original fabricated position. Moreover, bolts 204 hold joint elements 192, 194, rigidly to one another so as to form rigid joints 188, 190, which lend rigidity to deflector disk 114. Furthermore, the interlocking joint elements distribute stresses evenly in face and back skins 150, 152, and from one disk half to the other.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

As various changes could be made in the above constructions without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. A microwave reflector assembly adapted for installation on a vertically presented rigid support, said assembly comprising a mounting frame on said support, a reflector mounted on said mounting frame and first and second adjusting means for altering the angular relation of the mounting frame with respect to the vertically presented rigid support, the first adjusting means altering the azimuth relation of the frame to the support and the second adjusting means altering the elevation relation of the frame to the support, the mounting frame comprising a horizontal member located adjacent the horizontal axis of the reflector and two pairs of supporting members connecting the horizontal member to the rigid support, one pair of supporting members extending from one location on said support to opposite ends of said horizontal member and the other pair of supporting members extending from another location on said support to opposite ends of said horizontal member, the two pairs of supporting members supporting the microwave reflector assembly without substantial aid from either adjusting means.

2. A microwave reflector according to claim 1 in which the first adjusting means comprises first and second pivotal fittings secured to the mounting frame and vertical support, respectively, first and second threaded shanks rigidly fastened to and projecting from the first and second pivotal fittings, the first and second threaded shanks having opposite threads, a first sleeve interposed between the first and second shanks, the sleeve having first and second threaded ends which engage the threads of the first and second threaded shanks, respectively, means for changing the length of the sleeve, and means for locking the sleeve to at least one of the threaded shanks, whereby the distance between the pivotal fittings and the angular position of the mounting frame can be changed by rotating the sleeve.

3. A microwave reflector according to claim 2 in which the second adjusting means comprises third and fourth pivotal fittings secured to the reflector and mounting frame, respectively, third and fourth threaded shanks rigidly fastened to and projecting from the third and fourth pivotal fittings, the third and fourth threaded shanks having opposite threads, a second sleeve interposed between the third and fourth shanks, the second sleeve having third and fourth threaded ends which engage the threads of the third and fourth threaded shanks, respectively, means for changing the length of the second sleeve, and means for locking the second sleeve to at least one of the threaded shanks whereby the distance between the pivotal fittings and the angular position of the reflector can be changed.

4. A microwave reflector according to claim 3 in which the reflector comprises spars hingedly carried by the mounting frame, and an elliptical reflector disk rigidly carried by the spars in outwardly spaced relation to the mounting frame.

5. A microwave reflector according to claim 4 in which the reflector disk comprises a back skin, a face skin, and

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a plurality of ribs interposed between the face and back skins, the outwardly presented face of the face skin being planar whereby it reflects microwaves beamed at it, the spars being rigidly secured to the ribs.

6. A microwave reflector according to claim 5 in which the ribs are located at closely spaced intervals and extend transversely across the reflector disk.

7. A microwave reflector according to claim 5 in which the reflector disk is optionally separable into first and second disk halves, the back and face skins of the first and second disk halves having abutting margins.

8. A microwave reflector according to claim 7 and further characterized by first and second joint elements rigidly secured to the first and second disk halves along the abutting margins thereof, the first and second joint elements having opposed interlocking surfaces, and means for holding the opposed interlocking surfaces together in interlocking relation.

9. A microwave reflector according to claim 8 in which the ribs and abutting margins extend transversely across the reflector disk and in which the spars are provided with longitudinally extending flat base members which are located in perpendicular relation to the ribs, the reflector being further characterized by means associated with the

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spars and ribs for securely holding the reflector disk on the spars with the back skin in facewise abutment with the base members.

10. A reflector disk according to claim 9 and further characterized by a side rim interposed between the face and back skins and secured to the ends of the ribs, the side rim extending peripherally around the reflector disk.

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343—915