

June 26, 1962

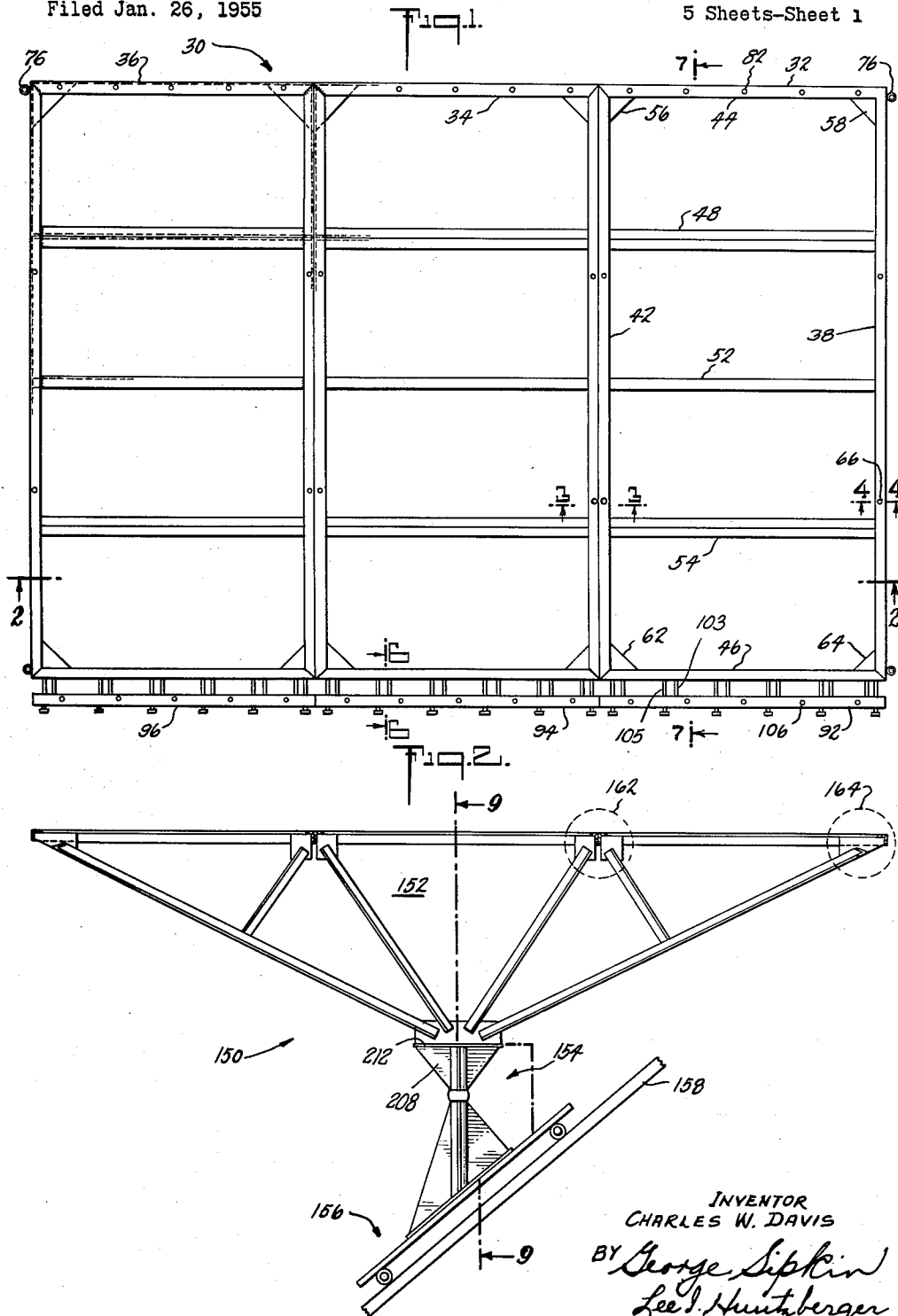
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3,041,603

PASSIVE REFLECTOR FOR MICROWAVE LINKS

Filed Jan. 26, 1955

5 Sheets-Sheet 1



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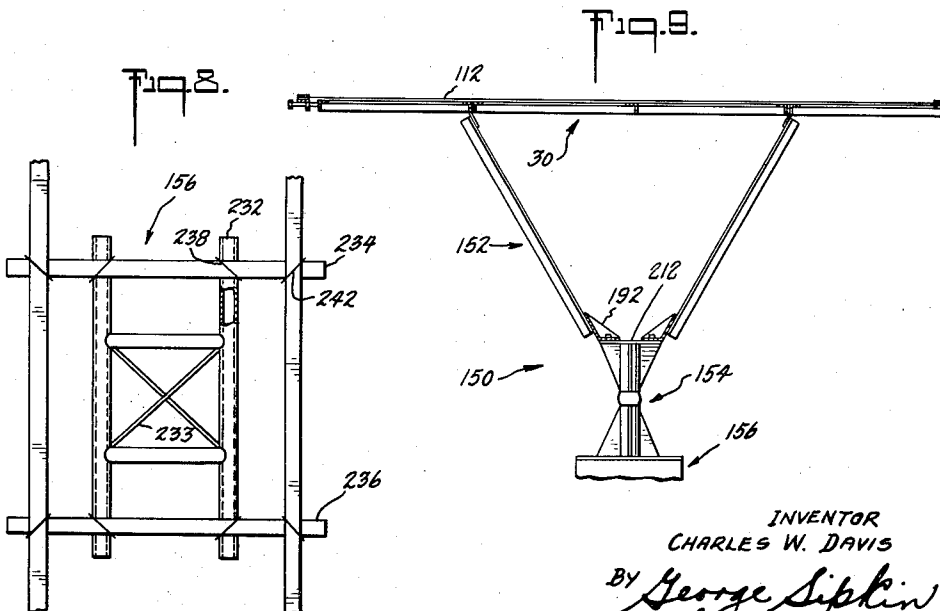
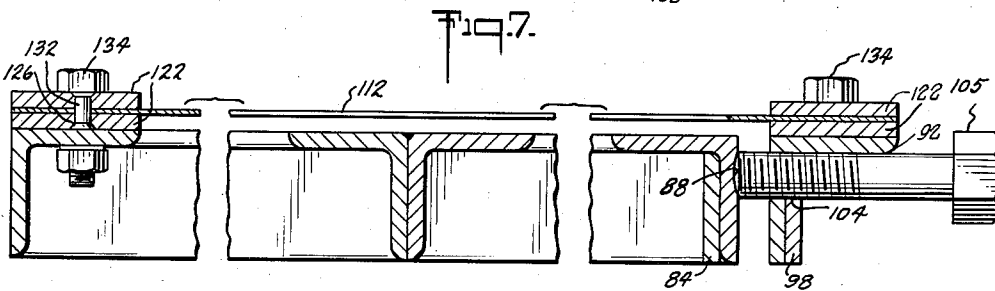
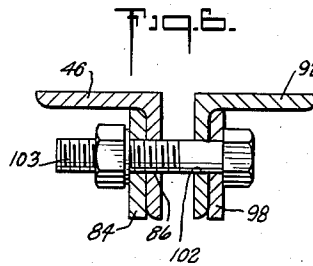
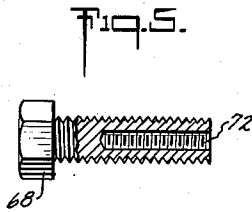
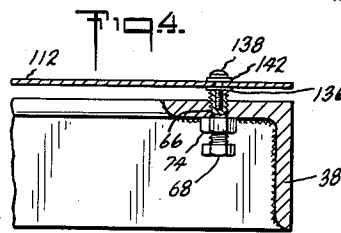
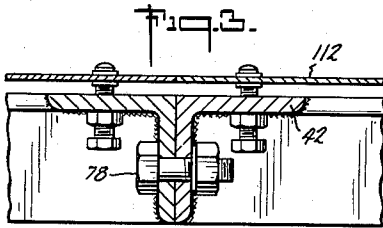
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PASSIVE REFLECTOR FOR MICROWAVE LINKS

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5 Sheets-Sheet 2



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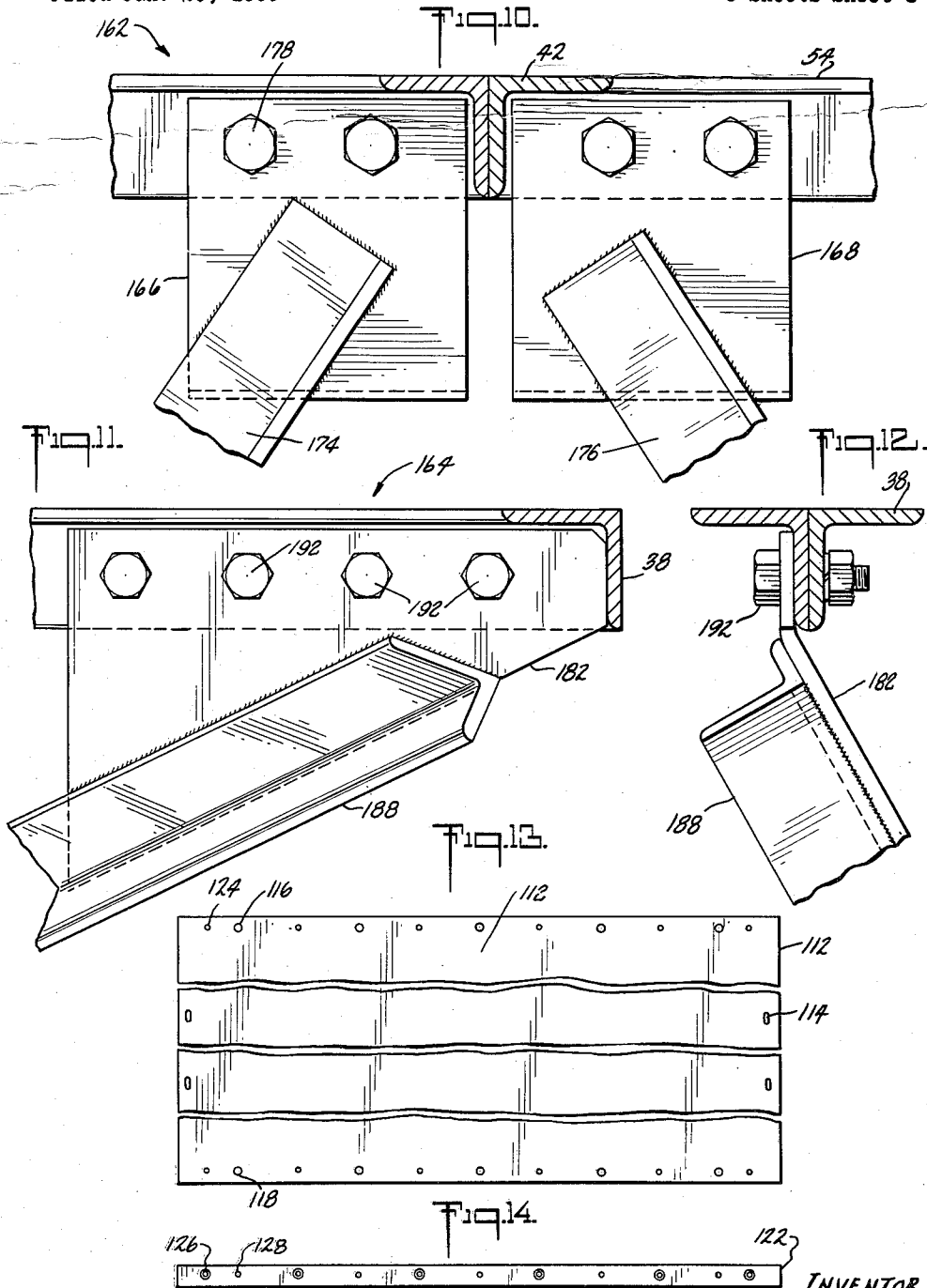
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PASSIVE REFLECTOR FOR MICROWAVE LINKS

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5 Sheets-Sheet 3



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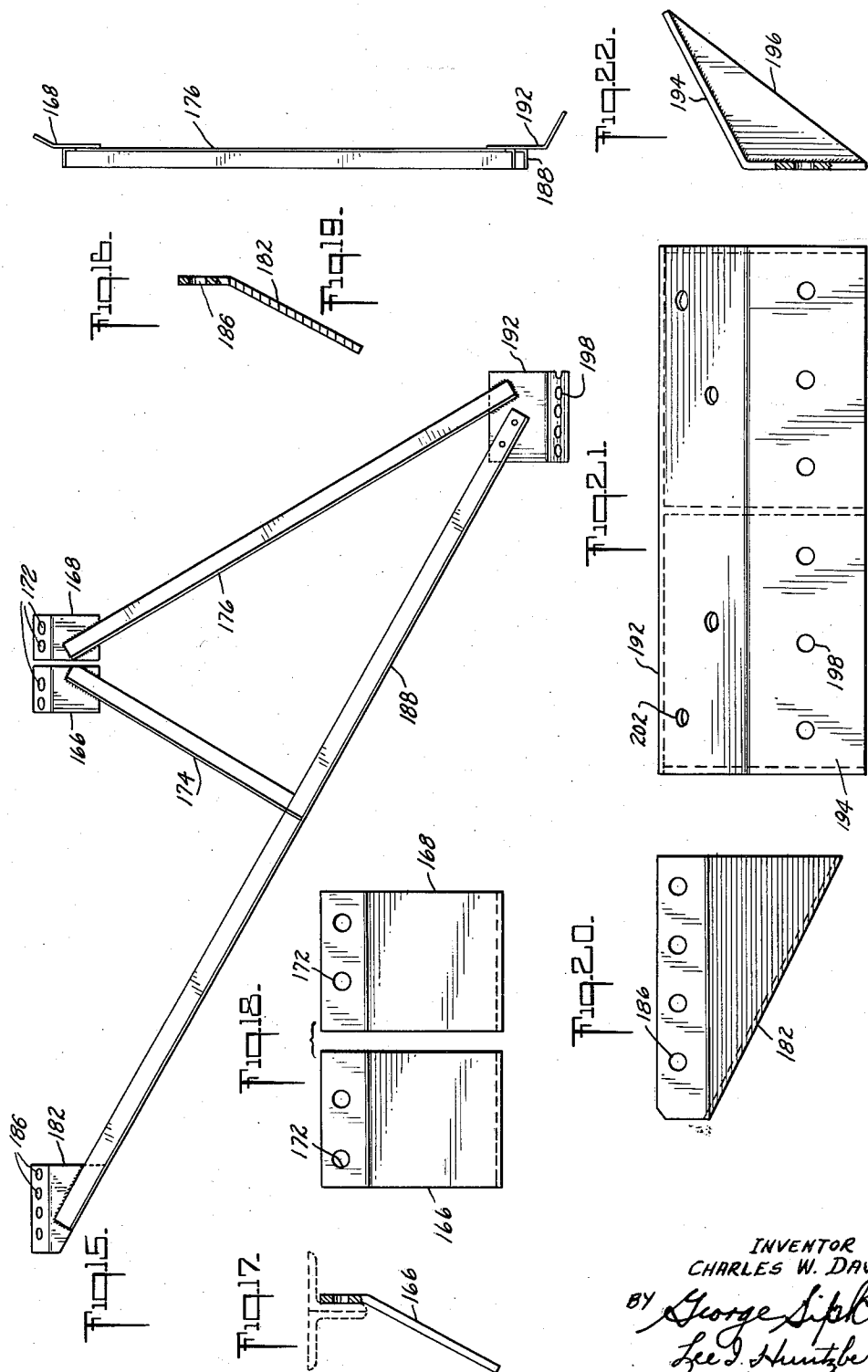
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PASSIVE REFLECTOR FOR MICROWAVE LINKS

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5 Sheets-Sheet 4



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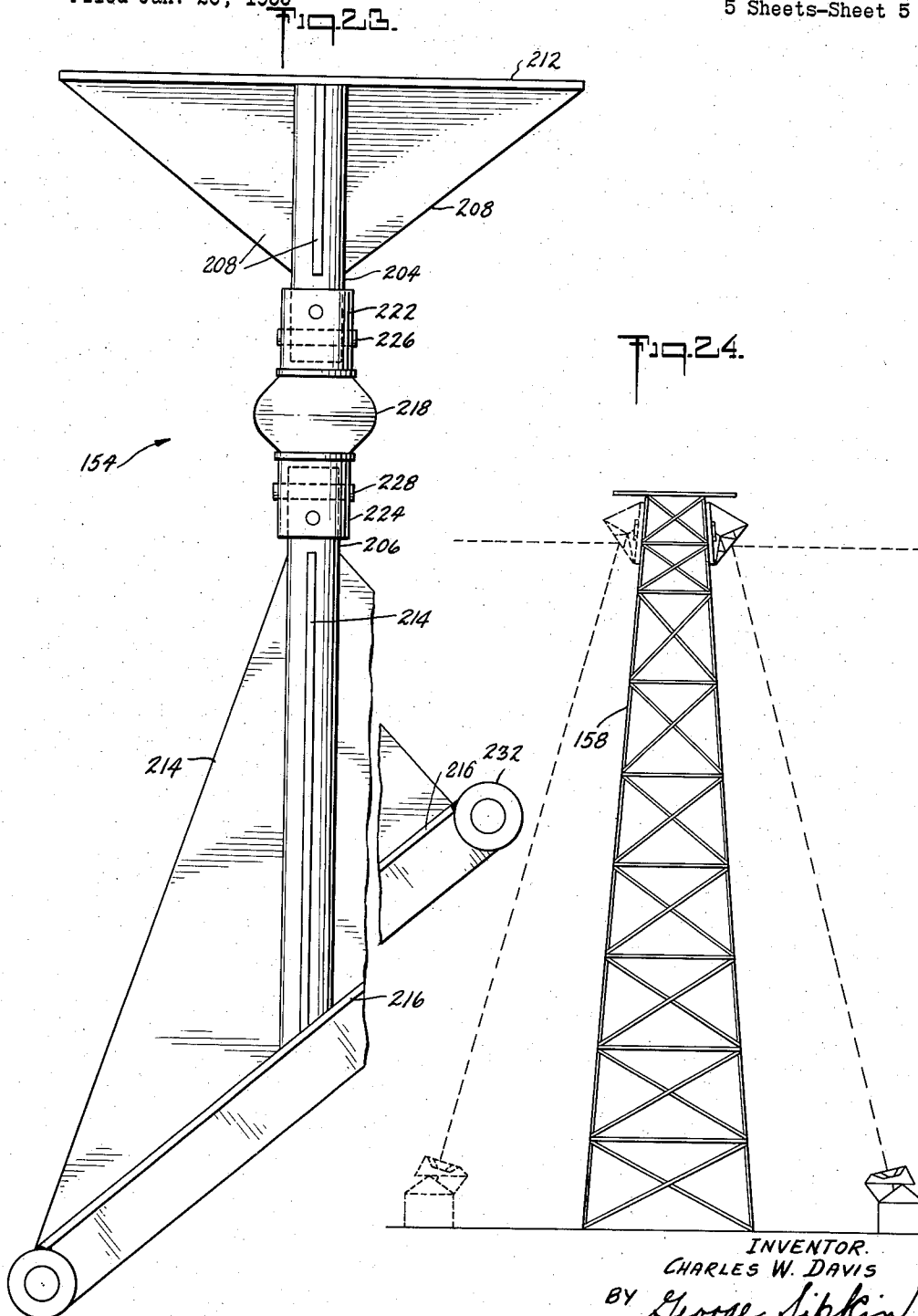
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PASSIVE REFLECTOR FOR MICROWAVE LINKS

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5 Sheets-Sheet 5



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PASSIVE REFLECTOR FOR MICROWAVE LINKS
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This invention relates to a passive reflector for microwave links and more particularly to a passive reflector for microwave links including an improved arrangement for assuring a planar reflecting surface for microwave energy.

In general microwave energy is transferred over long distances by a relay system including a series of spaced microwave links. Microwave energy is beamed from a first transmitting antenna and is directed toward a first receiving antenna of a first microwave link in the relay system. An amplifier circuit is included in each microwave link for raising the level of the microwave energy channelled through the microwave link to an extend sufficient to overcome attenuation of the energy incurred in the distance between a transmitting antenna and the receiving antenna to which the microwave energy is beamed. Each microwave link includes a transmitting antenna for beaming amplified microwave energy toward a subsequent microwave link.

For practical considerations it is advantageous to have the electronic circuitry of a microwave link at ground level and it is advantageous to locate the transmitting antenna and the receiving antenna of each microwave link immediately adjacent to the circuitry. Since the microwave energy traverses the space between microwave links in substantially a straight line, a tower is included in each microwave link to permit the energy to traverse the space clear of obstacles. Each tower supports two microwave energy reflectors at its upper end. These reflectors are oriented at the proper angle for cooperation with the antennas located at the base of the tower. One reflector redirects incident microwave energy at the top of the tower to the receiving antenna at the base of the tower and the other reflector redirects the amplified microwave energy from the transmitting antenna at the base of the tower toward the next microwave link of the relay system. Ideally, the reflectors only redirect the energy, nothing more.

An object of this invention is to provide an improved passive reflector for microwave links.

A further object is to provide a passive reflector for microwave links having an improved planar reflecting surface.

A further object is to provide an improved passive reflector for microwave links that includes a reflecting surface which is kept planar through application of continuous tension and through proper support.

A further object is to provide a passive reflector assembly for microwave links providing an improved planar reflecting surface that is adjustable in directional orientation.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

FIG. 1 is a top plan view of the passive reflector frame of a preferred embodiment of this invention,

FIG. 2 is a sectional view partly in elevation of the reflector assembly taken along line 2-2 of FIG. 1,

FIG. 3 is an enlarged sectional view taken along line 3-3 of FIG. 1 and including a passive reflector sheet,

FIG. 4 is an enlarged sectional view taken along line 4-4 of FIG. 1 and including a passive reflector sheet,

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FIG. 5 is an enlarged detail view, partly in section, of a post used for supporting the passive reflector sheet relative to the frame shown in FIG. 1,

FIG. 6 is a sectional view taken along line 6-6 of FIG. 1,

FIG. 7 is an interrupted sectional view taken along the line 7-7 of FIG. 1,

FIG. 8 shows an anchoring means for mounting a passive reflector assembly according to this invention on a tower with two vertical members of a tower shown in part,

FIG. 9 is a sectional view taken along line 9-9 of FIG. 2,

FIG. 10 is an enlarged view of an intermediate portion of the assembly shown encircled in FIG. 2,

FIG. 11 is an enlarged view of an end portion of the assembly shown encircled in FIG. 2,

FIG. 12 is a side view, partly in section, of the structure shown in FIG. 11,

FIG. 13 is an interrupted top plan view of one reflector sheet used in the preferred embodiment of this invention,

FIG. 14 is a top plan view of an end reinforcing strip for the reflector sheet of FIG. 13,

FIG. 15 is an enlarged view of a portion of the truss shown in FIG. 2,

FIG. 16 is a side elevation of the portion of the truss shown in FIG. 15,

FIGS. 17-22 are enlarged views of details of the truss,

FIG. 23 is a side elevation partially interrupted of the supporting means for the passive reflector, and

FIG. 24 is a diagrammatic showing of a microwave link.

There is shown in FIG. 1 the supporting frame 30 of the reflector. The supporting frame 30 includes 3 frame sections 32, 34, and 36. Frame 30 is formed preferably from steel angle. The frame section 32 is described as illustrative of the structure of all the frame sections. In frame section 32 there is secured together four lengths of steel angle 38, 42, 44, and 46 mitered together at their ends to form a rectangular frame. Opposite sides 38 and 42 of the rectangle are rigidly braced at three places at evenly spaced intervals. The bracing includes back-to-back steel angle members 48, angle member 52 and back-to-back steel angle members 54. The bracing members are welded at their ends to the sides 38 and 42. A triangular gusset plate is welded to each corner of the frame section 32 for added strength and rigidity. Each of the sides 38 and 42 of the frame section 32 is formed with a pair of threaded bores 66 (see also FIG. 4). A modified machine screw 68 (FIG. 5) is provided for threaded engagement with the threaded openings formed in the sides 38 and 42. The screw 68 is drilled and tapped longitudinally as at 72, FIG. 5. A lock nut 74, FIG. 4, is conventionally utilized in combination with machine screw 68. The ends of the modified machine screws 68 project through the surface of the frame to provide supporting posts for the reflector sheets subsequently described. The three frame sections 32, 34, and 36 are bolted together by bolt and nut assemblies 78 (FIG. 3). An eye 76, FIG. 1, is secured near each end of the outer sides of the frame sections 32 and 36 for ease in handling the frame.

A plurality of evenly spaced bolts holes 82, FIG. 1, are formed along one end of each of the sections 32, 34, and 36 of the frame. The depending flange of the opposite end of the frame is reinforced with a flat strip 84 (FIG. 6) welded in place. The reinforced depending flange of the end 46 is formed with five spaced threaded bores 86. The depending flange is formed with shallow circular depressions 88 (FIG. 7) alternating with the threaded bores 86.

Stretching bars 92, 94, and 96 (FIG. 1) of steel angle

are provided for the sections 32, 34, and 36 respectively, of the frame 30. The depending flange of the stretching bar 92, taken as illustrative, is reinforced by means of a flat strip 98 (FIG. 7) welded in place. The reinforced depending flange is formed with a first series of bores 102 (FIG. 6) for alignment with the threaded bores 86 formed in the depending flanges of the ends 46 of the frame sections. Bolts 103 extend through the bore 102 in the depending flanges of the stretching bars and are threaded into the depending flanges of the ends 46 of the frame for supporting the stretching bars on the frame. Lock-nuts and lockwashers are conventionally provided for the bolts 103. The depending reinforced flanges of the stretching bars are further formed with a series of threaded bores 104 (FIG. 7) for alignment with the shallow circular depressions 88 in the depending flanges of the ends 46 of the frame sections. Bolts 105 are threaded into the bores 104 for bearing engagement with the shallow circular depressions 88. The horizontal flanges of the stretching bars are formed with a series of evenly spaced bores 106 (FIG. 1) corresponding to the bores 82 formed in the ends 44 of the frame sections. At assembly the horizontal flanges of the stretching bars are coplanar with the top of the frame 30.

In FIG. 13 there is shown one of the metallic reflector sheets 112 for assembly to the frame 30 (see also FIGS. 3, 4, 7 and 9). The sides of the reflector sheets 112 are formed with elongated openings 114 (FIG. 13) for alignment with the openings 66 (FIGS. 1 and 4) formed in the sides 38 and 42 of the frame sections. The ends of the reflector sheets 112 are formed with spaced openings 116 for alignment with the bores 82 formed in the frame side 42, and spaced openings 118 for alignment with the bores 106 formed in the horizontal flanges of the stretching bars, respectively. Both ends of the reflector sheet 112 are reinforced by means of reinforcing strips 122 (FIG. 14). A pair of reinforcing strips 122 sandwich each end of the reflector sheet 112 (FIG. 7). Each end of the reflector sheet 112 is formed with rivet holes 124 (FIG. 13) and the reinforcing strips 122 are formed with countersunk rivet holes 126 (FIGS. 7 and 14). The sheet 112 and reinforcing strips 122 are secured by means of rivets 132 (FIG. 7). Reinforcing strips 122 are further formed with openings 128 for alignment with the openings 116 and 118 formed in the ends of the reflector sheet 112. Bolt and nut assemblies 134 (FIG. 7) secure one of the sandwiched ends of the reflector sheets 112 to the ends 44 of the frame sections and the opposite sandwiched ends of the reflector sheets to the stretching bars. The sheets are tensioned by adjustment of bolts 105 which act to force the stretching bars away from the frame sections and in sliding engagement with the bolts 103. After adjustment of bolts 105 for properly tensioning the sheets 112 the bolts 103 (FIG. 6) are tightened and secured by locknuts and lockwashers.

The elongated openings 114 along the sides of the sheets 112 are located for alignment with corresponding posts 68 threadedly engaged with the sides of the rectangular frame sections. A washer 136 is disposed at the top of each post. A screw 138 and washer 142 are assembled with each post 68 to secure the sides of the sheet 112 at assembly after they are under tension.

A supporting unit 150 (FIG. 2) is provided for the passive reflector. The support 150 generally includes a truss 152, a universal mount 154, and an anchoring means 156. The truss 152 supports the reflector on the universal mount 154. Universal mount 154 is in turn connected to the anchoring means 156. The anchoring means 156 is adapted to fixedly secure the passive reflector assembly to a tower 158.

The truss 152 is secured to the frame 30 by a structural arrangement generally shown at the encircled portions 162 and 164 of FIG. 2. The description below of the truss though only given in part is illustrative of the remainder of the truss. The described structure is du-

plicated four times to form the truss. The encircled portion 162 is enlarged and detailed in FIG. 10 and the encircled portion 164 is enlarged and detailed in FIGS. 11 and 12. The portion 162 (FIG. 10) includes a pair of bent anchoring gussets 166 and 168 (see also FIGS. 15, 17, and 18). The anchoring gussets 166 and 168 are each formed with a pair of bolt holes 172 (FIG. 15). One end of each of the struts 174 and 176 is welded to the anchoring gussets 166 and 168, respectively. The anchoring gussets 166 and 168 are secured, in turn, by means of bolt and nut assemblies 178 (FIG. 10) to the steel angle braces 54 of the frame sections immediately adjacent the sides 42 of the frame. The encircled portion 164 (FIGS. 11 and 12) includes a bent anchoring gusset 182 of triangular shape (see also FIGS. 19 and 20) formed with four bolt holes 186 (FIGS. 19 and 20). The strut 188 of the truss is welded at one of its ends to the triangular anchoring gusset 182. The triangular anchoring gusset 182 is secured by means of bolt and nut assemblies 192 (FIGS. 11 and 12) to the end of steel angle brace 54 (FIG. 1) adjacent the side 38 of the frame section. One end of each of the struts 174 and 188 are welded to the anchoring gussets 166 and 182 respectively (FIG. 15). The opposite end of strut 174 is welded to the central portion of strut 188 normal thereto. The opposite ends of the struts 176 and 188 are secured to a reinforced anchoring means 192 (see also FIGS. 21 and 22). The reinforced anchoring means 192 includes a bent rectangular member 194 (FIGS. 21 and 22) and reinforcing ribs 196 welded to its ends and to its center. The angularly bent elongated member 194 is formed with six bolt holes 198. It is further formed with a pair of bolt holes 202. An end of the strut 176 is welded to the reinforced anchoring means 192 (FIG. 15). The free end of strut 188 is secured to the reinforced anchoring means 192 by means of bolt and nut assemblies. By using this combination of securing means the truss may be prefabricated as subassemblies for rapid assembly at the site. Each half of the truss includes three subassemblies. One subassembly includes anchoring gusset 168, strut 176 reinforced anchoring means 192, a second strut 176, and a second anchoring gusset 168. The second and third subassemblies of each half of the truss each include a bent anchoring gusset 182, a strut 188 welded thereto, a strut 174 welded to the strut 188 intermediate its ends and perpendicular thereof, and an anchoring gusset 166 welded to the free end of the strut 174. The truss subassemblies are assembled through the use of bolt and nut assemblies.

The universal mount 154 to which the truss 152 is anchored is shown in FIG. 23. It includes a pair of steel rods 204 and 206. Four identical triangular steel ribs 208 are welded to rod 204. A flat mounting plate 212 is welded to the rod 204 and the steel ribs 208, normal to both. Four triangular steel reinforcing ribs 214 designed to define a plane oblique to the rod 206 are welded to the rod 206. A flat mounting plate 216 is welded to the ribs 214 and the rod 206. A commercial type of universal joint 218 such as an Apex heavy duty industrial joint 270-B-40 having end portions 222 and 224 and coupling means 226 and 228 is connected to the shafts 204 and 206, respectively. The truss 152 is anchored to the flat mounting plate 212 by bolt and nut assemblies (FIGS. 2 and 9).

The anchoring means 156 for the passive reflector includes a welded and braced tubing unit 232 (FIG. 8) including crossed steel bars 233, the unit being welded to the plate 216 (FIG. 23). Welded tubing unit 232 is clamped to a pair of tubes 234 and 236 by clamps diagrammatically shown at 238 (FIG. 8). Clamps 242 anchor the passive reflector assembly to a tower 158 (FIG. 24).

In operation the passive reflector assembly is adjusted so that the reflector sheets 112 define a common plane surface. The posts 68 (FIG. 4) are adjusted to the

proper height to space sheets 112 from the frame and the stretching bars 92, 94 and 96 are adjusted to properly tension the reflector sheets 112 to insure a planar reflecting surface. While the stretching bars 92, 94 and 96 are being adjusted the screws 138 on the posts 68 and in registration with the elongated openings 114 of reflector sheets 112 are loosened so as to permit stretching movement of the sheets relative to the supporting posts 68. The tensioning is accomplished by threading outwardly the bolts 102 and then tightening the bolts 105 so that they force the stretching bars away from the frame 30 thereby applying a tensioning force to the respective sheets 112. When the sheets 112 are stretched flat the bolts 102 are threaded tightly into the frame and secured by means of nuts and lockwashers. Finally the screws 138 are threaded tightly into the posts 68. These posts aid in preventing sag in the reflector sheets. The entire assembly is mounted as shown in FIG. 24. The universal mount 154 supports the reflector on a tower and permits adjustment of the orientation of the surface of the passive reflector so that it is properly aligned with the antennas at the foot of the tower and with the reflectors or antennas of linking portions of the relay system.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

I claim:

1. A passive reflector for microwave links comprising; a rectangular metallic sheet; rigid reinforcing strips secured to opposite ends of said metallic sheet; a rigid rectangular frame; means securing one reinforced end of said sheet to one end of said frame; a stretching bar; a plurality of bolts extending through said stretching bar and threaded into the opposite end of said frame for drawing said stretching bar toward said frame; a second plurality of bolts threaded into said stretching bar and extending through said stretching bar into abutment with said frame for forcing said stretching bar away from said frame; means securing the opposite reinforced end of said sheet to said stretching bar whereby said sheet is adapted to be stretched taut to present a planar surface by adjustment of said first and second plurality of bolts.

2. A passive reflector for microwave links comprising; a rectangular metallic sheet formed with a plurality of openings along each of its sides and each of the openings being elongated parallel to the sides of said sheet; a pair of rigid reinforcing strips secured to and sandwiching each end of said metallic sheet; a rigid rectangular frame defining a plane; a plurality of support means secured along the sides of said frame for registration with respective ones of the plurality of elongated openings formed in said sheet, each of said support means including a post fixedly secured to and projecting from said frame and a screw threaded longitudinally into the end of the post clamping said sheet therebetween; means securing one end of said reinforced sheet to one end of said frame; a stretching bar; a plurality of bolts extending through said stretching bar and threaded into the opposite end of said frame, said bolts extending in a direction parallel to the plane defined by said frame for drawing said stretching bar toward said frame; a second plurality of bolts threaded into said stretching bar and extending through said stretching bar in parallel with the first said plurality of bolts into abutment with said frame and adapted to force said stretching bar away from said frame; means securing the opposite reinforced end of said sheet to said stretching bar whereby said sheet may be drawn taut to present a planar surface by adjustment of said first and second plurality of bolts which planar surface is parallel to the plane defined by said frame and is spaced therefrom a distance equal to the height of said posts and the thickness of said reinforcing strips.

3. A passive reflector for microwave links as recited in claim 2 in combination with means for mounting said reflector which means includes a truss secured to said frame and a universal joint secured to said truss.

4. A passive reflector assembly for microwave links comprising; a plurality of identical relatively thin gage elongated metallic sheets; two pairs of rigid end-reinforcing strips for each of said sheets, one pair of said end-reinforcing strips securely sandwiching one end of one sheet therebetween and the other pair of strips securely sandwiching the opposite end of the one sheet therebetween; a rigid rectangular frame defining a plane surface; fastening means securing one sandwiched end of each sheet to one end of said frame whereby said sheets are disposed side-by-side; a stretching bar for each of said sheets; fastening means securing the other sandwiched end of each sheet to a respective stretching bar; a first plurality of bolts extending through each of said stretching bars and threadedly engaging the end opposite the one end of said frame, and a second plurality of bolts for each of said stretching bars threaded into and extending through each stretching bar to abut said frame whereby said stretching bars are adjustable by adjustment of said first and said second plurality of bolts for stretching the respective sheets flat; each of said sheets being formed with a plurality of elongated openings along each side of each sheet; supporting spacer means secured to said frame and in sliding registration with respective elongated openings formed in said sheets to aid in keeping said sheets planar; and means including a universal joint for securing said reflector to a tower.

5. In a microwave transmission system in which a flat reflector is mounted on a structure for adjustment into different angular positions for determining the direction in which microwaves incident thereon will be propagated, that improvement in said reflector which comprises a flat metallic reflector sheet having a pair of approximately parallel opposite end edges, a supporting frame for such sheet and approximately coextensive in length and width with those of said sheet, and said sheet being superposed on said frame in approximate alignment thereon, means for securing one of said opposite end edges of said sheet to a corresponding edge of said frame, screw means acting between the other of said opposite end edges of said sheet and said frame and applying adjustable tension to said sheet in a direction between its said opposite end edges, the opposite side edges of said sheet having along their marginal areas, apertures from face to face of the sheet and elongated in directions between said end edges, studs carried by said frame along said side edges of said sheet, projecting from the frame toward the faces of the sheet and each passing through one of said elongated apertures, and means for clamping the side edges of said sheet to the free ends of said studs along corresponding sides of said frame with the sides of said sheet spaced from said frame, while the sheet is under said tension.

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