GUYED TOWER FOR MICROWAVE HORNS

Filed March 1, 1967 6 Sheets-Sheet 1

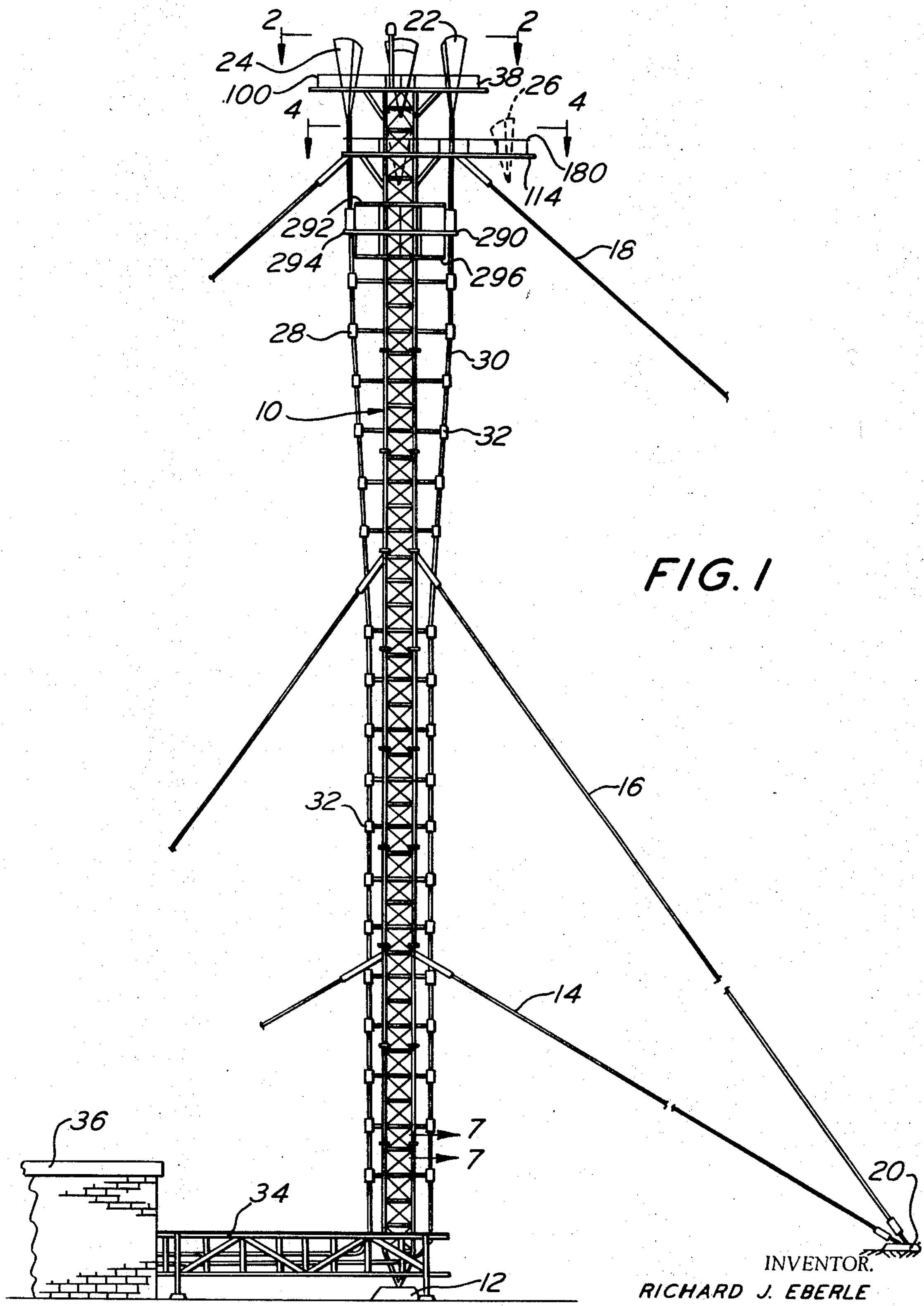

FIG. 1

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GUYED TOWER FOR MICROWAVE HORNS

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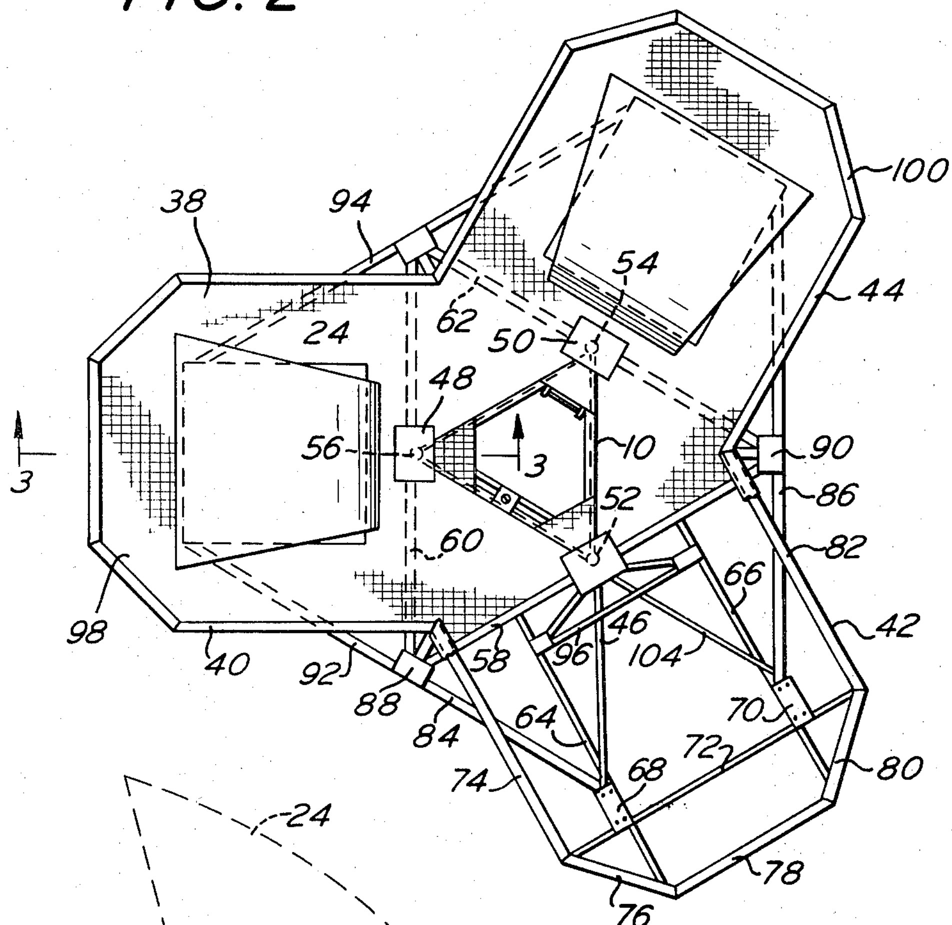
FIG. 2



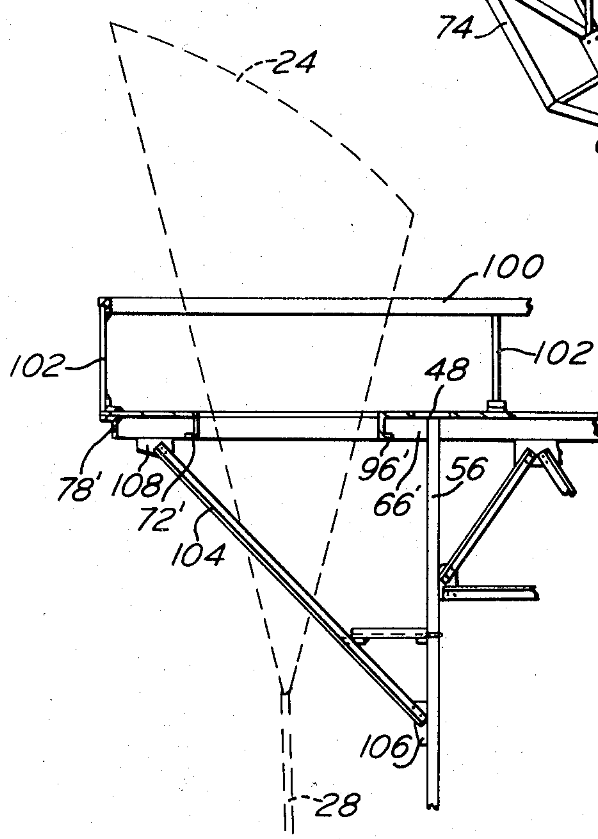


FIG. 3

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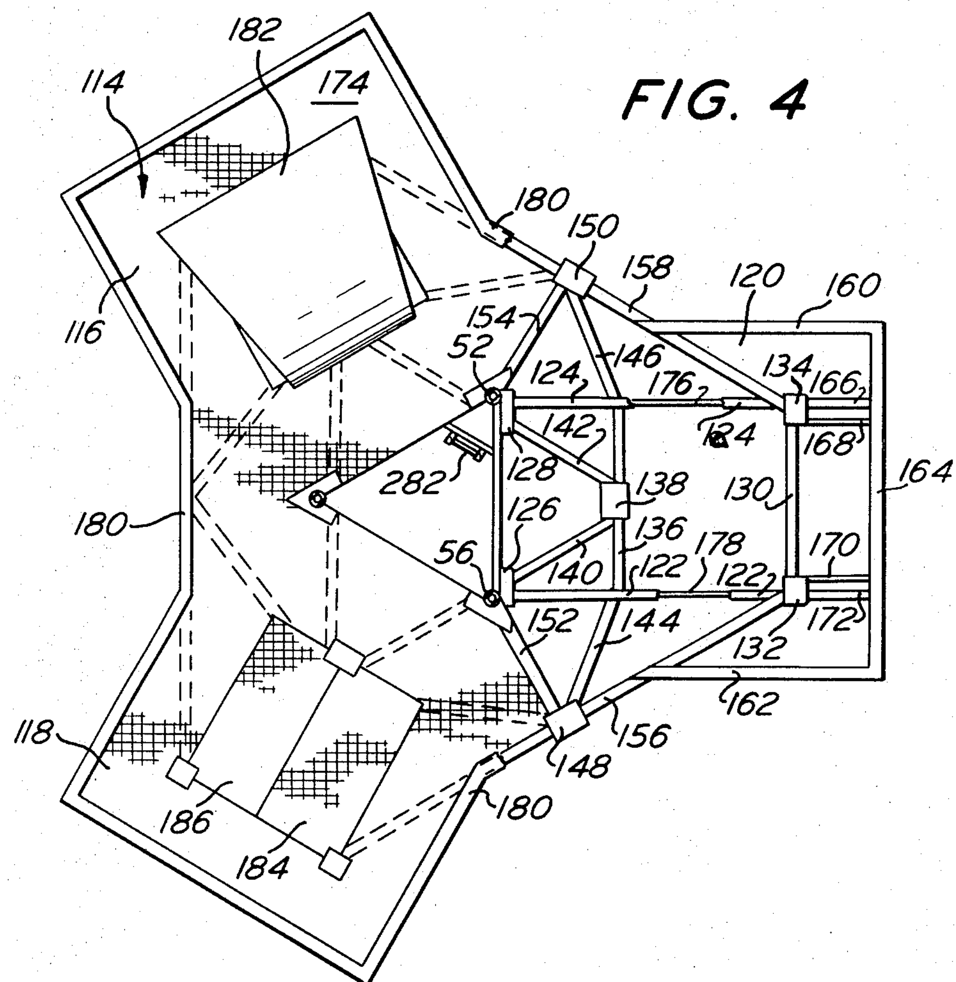

FIG. 4

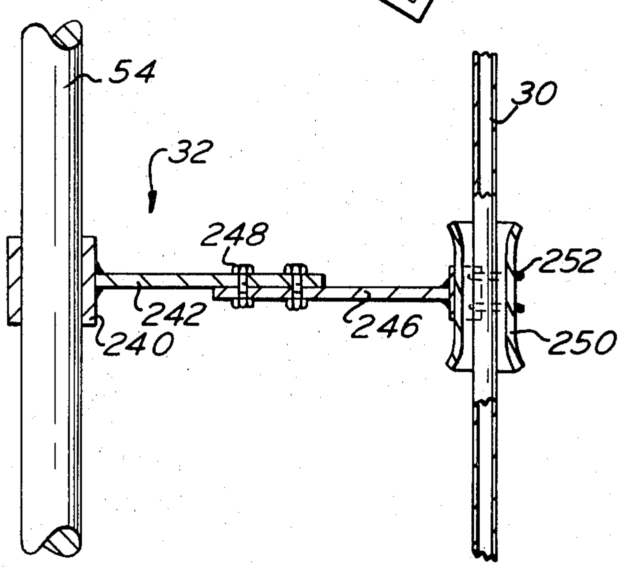

FIG. 8

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FIG. 5

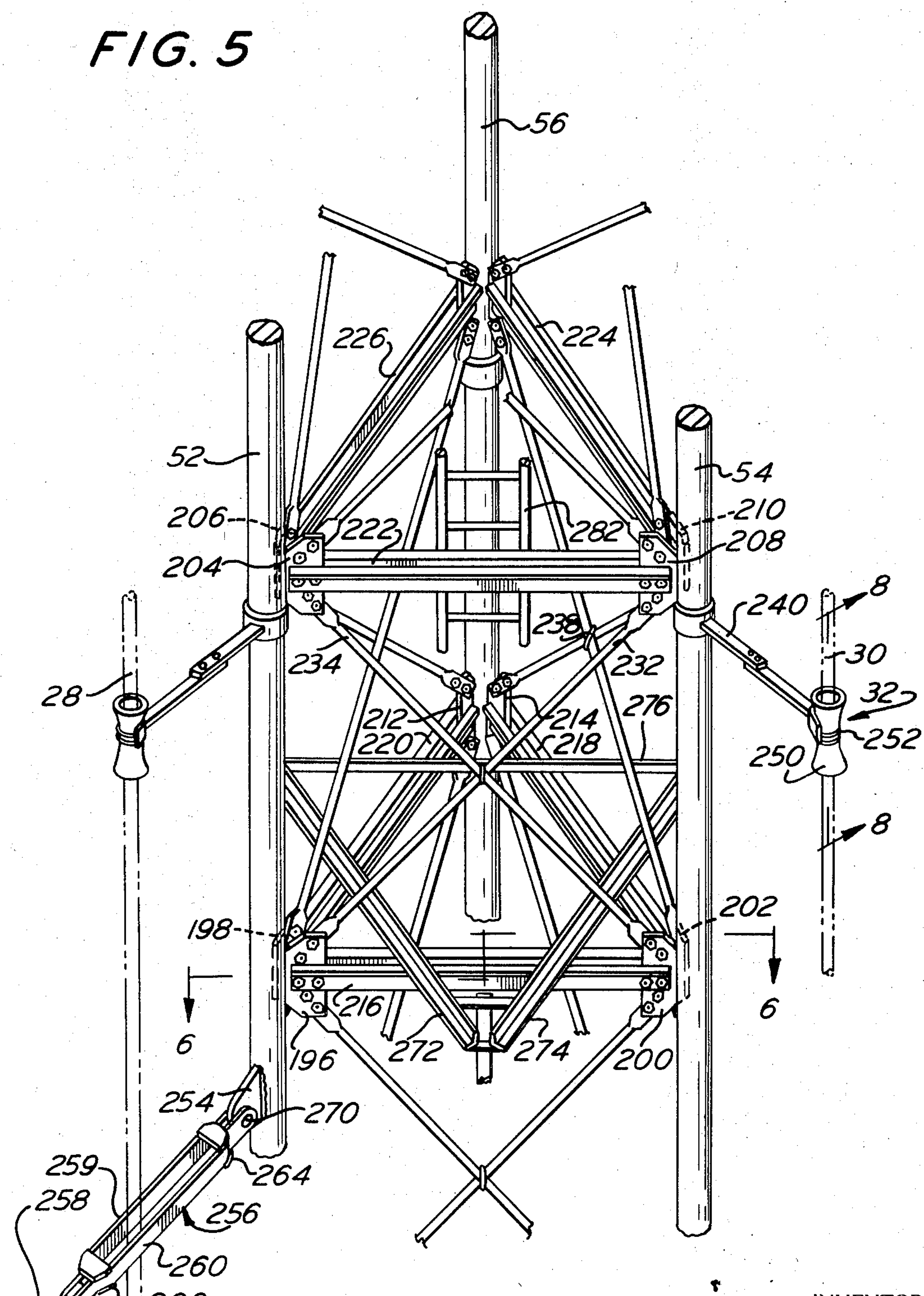

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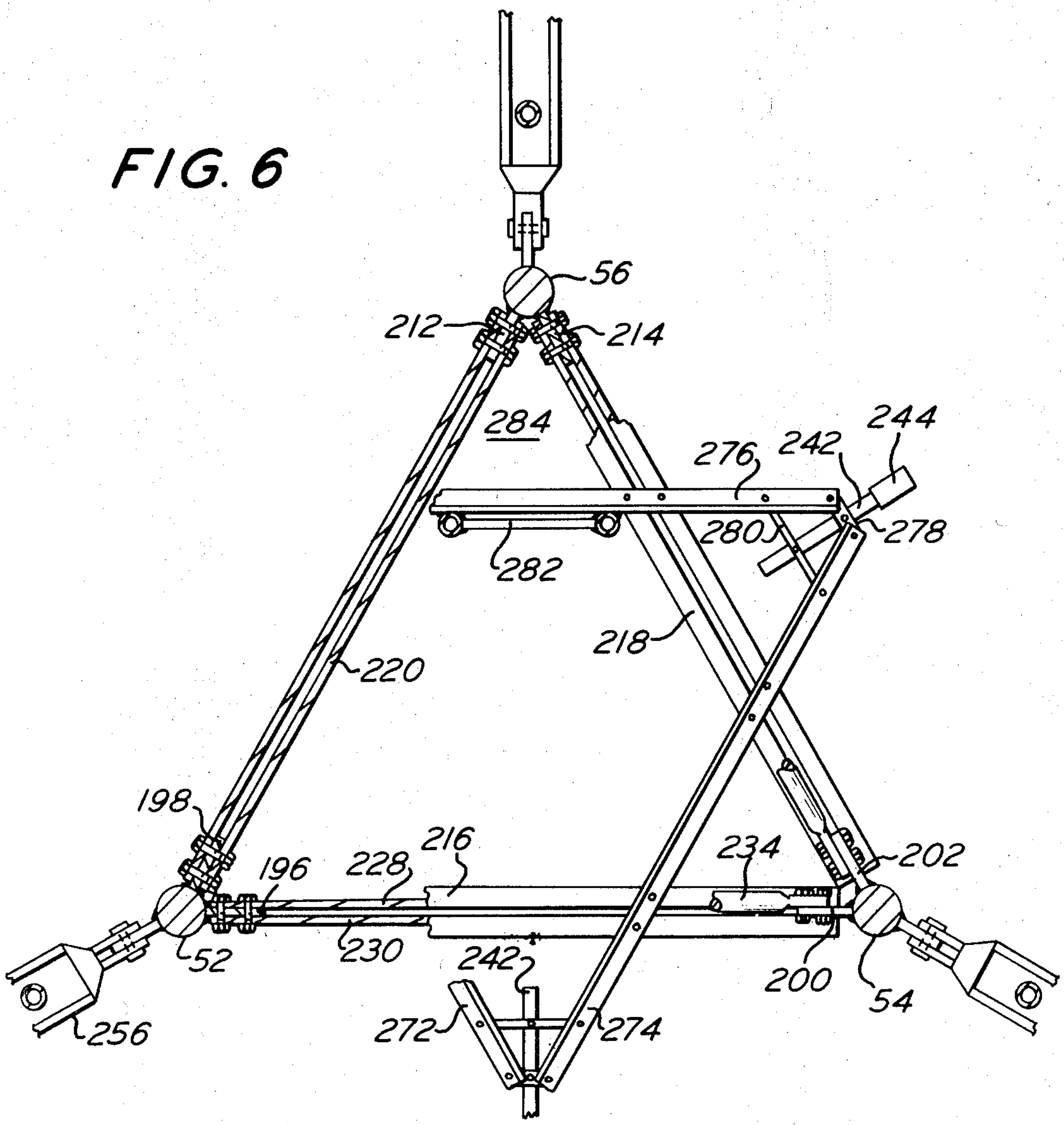
FIG. 6



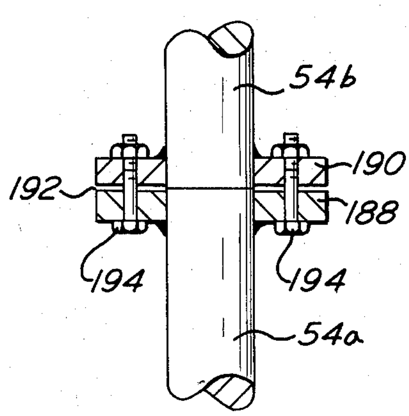


FIG. 7

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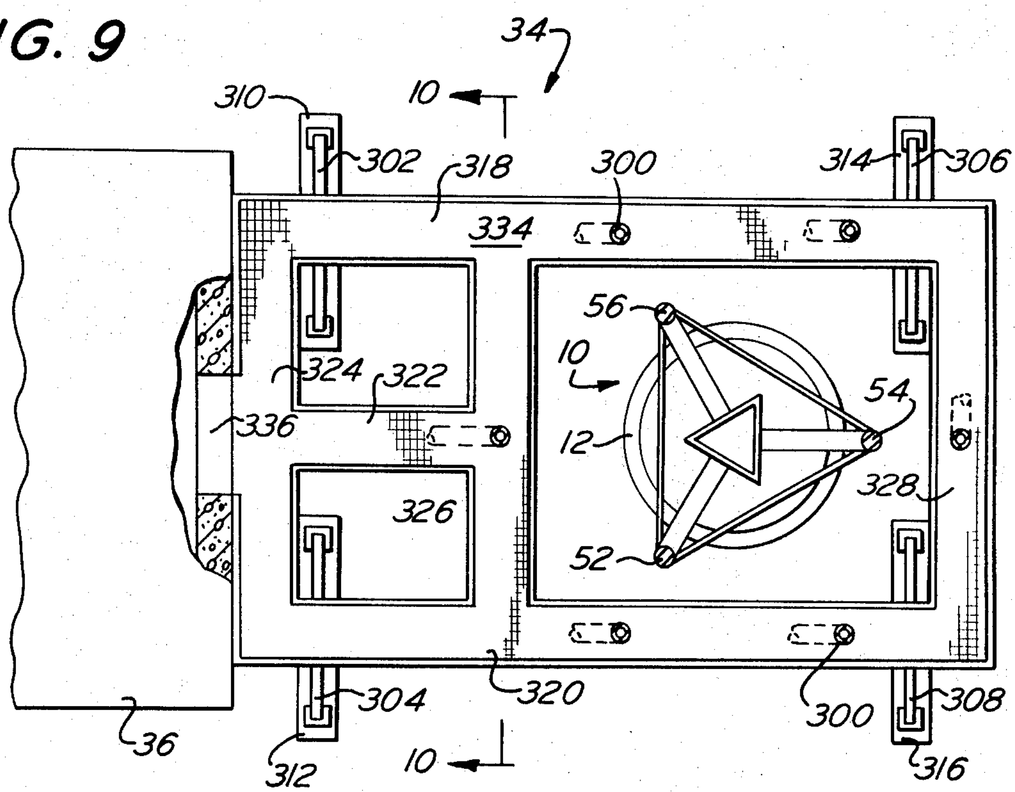
FIG. 9



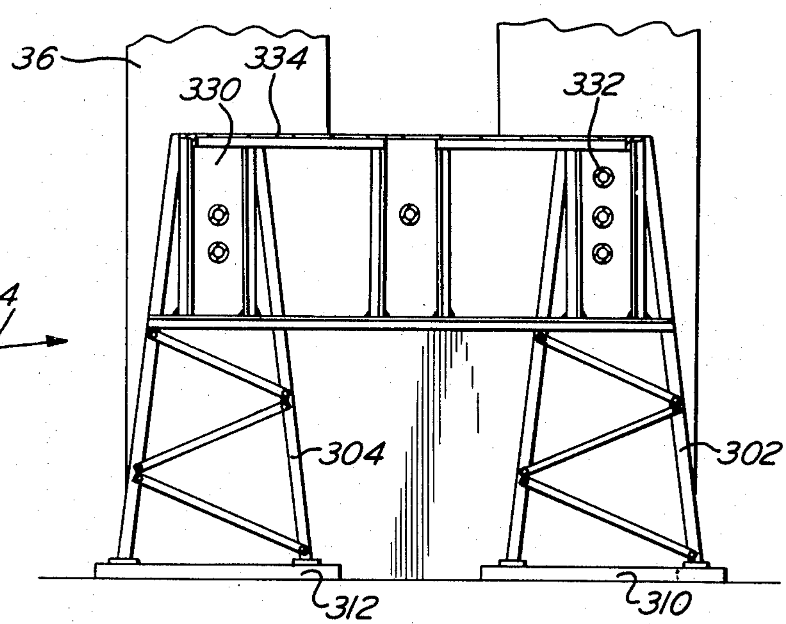


FIG. 10

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United States Patent Office

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GUYED TOWER FOR MICROWAVE HORNS

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U.S. Cl. 343—879 7 Claims

ABSTRACT OF THE DISCLOSURE

A guyed tower for supporting microwave horns having three platforms. The upper two platforms accept three horns each at 120° spacing over full 360°. A third platform is provided for passive devices. Tower includes adjustable wave guide supports and wave guide bridge.

Guyed and self-supporting antenna towers have heretofore been constructed and used. Such towers are normally designed and built for a specific use with little or no thought being given to the provision of a tower with sufficient flexibility that it can be modified to take on additional electronic handling characteristics once it is completed. The present invention relates to a guyed microwave tower which is designed to support between 1 and 6 microwave horns. The number of horns can be changed at any time after the tower has been completed. Thus, the present invention provides a tower which permits expansion of facilities in the future with only moderate additional costs as compared to the cost of completely redesigning and erecting a new tower.

The present invention relates to a guyed microwave tower in the range from 100 to 400 feet which is capable of meeting the high specification and standards set forth by the telephone companies. The tower includes an upper and lower platform for mounting three horn reflector antennas each. The reflectors are mounted at angles of 120° on their respective platforms, and the upper and lower platforms are displaced 60° with respect to each other. Thus, when a tower carries a full complement of six horn reflectors, they cover a full 360° at spaced angles of 60°. A third platform is provided for supporting passive reflectors if desired. The tower is so designed so that it can be initially constructed with one platform with provision for adding the second platform at a later time.

Adjustable wave guide supports are provided and a novel bridge structure adjacent the transmitter building is provided for supporting and protecting the wave guides.

For the purpose of illustrating the invention, there is shown in the drawings a form which is presently preferred; it being understood, however, that this invention is not limited to the precise arrangements and instrumentalities shown.

FIG. 1 is an elevational view of a guyed tower constructed in accordance with the present invention and including a wave guide bridge structure for supporting the wave guides into a transmitter building.

FIG. 2 is a top plan view of the upper platform illustrated in FIG. 1 taken along the line 2—2.

FIG. 3 is a partial sectional view of the platform illustrated in FIG. 2 taken along the line 3—3.

FIG. 4 is a top plan view of the lower platform illustrated in FIG. 1 taken along the line 4—4.

FIG. 5 is a partial perspective view of the tower structure.

FIG. 6 is a plan view of the tower structure illustrated in FIG. 5 taken along the line 6—6.

FIG. 7 is a partial sectional view of the flange connection for the vertical supporting member illustrated in FIG. 1 taken along the line 7—7.

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FIG. 8 is a partial sectional view illustrating the adjustable wave guide support of FIG. 5 taken along the line 8—8.

FIG. 9 is a plan view of the wave guide supporting bridge.

FIG. 10 is a sectional view of the wave guide supporting bridge illustrated in FIG. 9 and taken along the line 10—10.

Referring now to the drawings in detail, wherein like numerals indicate like elements, there is shown in FIG. 1 a guyed microwave horn reflector tower designated generally as **10**.

As shown, the tower **10** is vertically supported on a base **12** and laterally supported by one or more levels of guy wires. By way of example, three levels **14**, **16** and **18** are shown. The guy wires **14**, **16** and **18** extend from the vertical tower members to be described below and are anchored as at **20**. The base **12** and anchors **20** are conventional. Accordingly, they will not be described in detail. The special saddle connection between the guy wires and the tower is described below.

The tower **10** is constructed to support six microwave horn reflectors such as the reflectors **22**, **24** and **26**. The reflectors **22**, **24** and **26** form no part of this invention and will not be described in detail except to indicate that their function is to reflect and transmit microwaves. Each of the reflectors is connected to a wave guide, such as wave guides **28** and **30**, which pass through wave guide restrainers supported on the tower **10** and a wave guide bridge **34** into the transmitter building **36**.

Referring now to the remaining figures of the drawing, the tower **10** will be described in detail.

FIGS. 2 and 3 illustrate the uppermost platform **38** and the supporting structure therefor, as well as a detailed view of the support for horn reflector **24**. The platform illustrated in FIG. 2 is shown with the grating in position except on one of the legs wherein it has been removed to show the detail of the structural elements.

As shown, the upper platform **38** is constructed to define three legs **40**, **42** and **44** extending from the central tower **10** at angles of 120° with respect to each other. Each leg is constructed by fixing a plate, such as gussets **46**, **48** and **50** to one of the vertical support members **52**, **54** and **56**. The main frame is defined by channel members **58**, **60** and **62** which are bolted or otherwise fixed to the gussets **46**, **48** and **50** to define a triangle rotated 60° from the triangle defined by the vertical support members. Extending outwardly from the channel member **58** are a pair of parallel channel members **64** and **66** which are joined to the gussets **68** and **70**. A channel member **72** extends across the channel members **64** and **66** and is also joined to the gussets **68** and **70**. Outer angle members **74**, **76**, **78**, **80** and **82** are joined endwise and to the channel members **58**, **64**, **66**, and **72** to define the outer perimeter of the platform leg **42**. Angle members **84** and **86** extend at an angle from gussets **68** and **70** to gussets **88** and **90**. Similar angle members such as **92** and **94** are provided for each of the platform legs so that when completely assembled, they define a triangle support with sides generally parallel to the side **10**. This latter triangle is not a true triangle in the sense that the angle members defining its sides do not join each other to form the triangle apices.

The leg **42** described above is constructed to support a horn reflector within the opening defined by the angle members **64**, **66**, **72** and **96**. The parallel angle members such as **64**-**74**; **72**-**78**; and **66**-**82** are adapted to receive removable gratings illustrated schematically as **98** on which a workman can move about the horn microwave reflector.

Referring now to FIG. 3, a sectional view of the platform leg **40** illustrates the manner in which the horn reflector is supported. Leg **40** is identical with previously described leg **42**. Accordingly, like elements have been designated with like numerals except a prime has been added. In addition, FIG. 3 illustrates how the safety railing **100** is supported over the perimeter of the platform **38** by posts **102** which are connected to the outer angle members.

The platform leg **40** receives additional support by means of the angle member **104** which extends outwardly from a gusset **106** that is fixed to the vertical support member **56**. At its opposite end it is fixed to a gusset **108** depending from the angle member **66**. As shown in FIG. 2, a similar angle member **110** extends from the post **52** to the angle member **64**.

The horn reflector **24** extends through the opening in the platform leg **40** and is supported therein by conventional means which are not shown.

The entire platform **38** is constructed so that it can be partly or wholly assembled at ground level and then hauled to the top of the tower for installation. If the tower is originally intended for use for three or less horn reflectors, then the upper platform is not installed. However, if additional facilities are needed, then the platform can be assembled and mounted at the top of the tower to provide support for three additional horn reflectors. It should be noted that the longitudinal axis of each leg **40**, **42** and **44** of the platform **38** extends outwardly from the vertical supporting members **52**, **54** and **56**. As will be explained below, central longitudinal axes of the legs of the lower platform extend outwardly from the center of the sides defined by the tower structure. Thus, the legs of the lower platform are displaced 60° from the legs of the upper platform.

The structure of lower platform **114** is generally similar to that of upper platform **38**. Thus, it is constructed to define three platform legs **116**, **118** and **120** at angles of 120° with respect to each other. Since all three legs are similarly constructed, only leg **120** will be described in detail.

As shown, channel members **122** and **124** extend outwardly from gussets **126** and **128** fixed to the vertical support members **48** and **56**. A channel member **130** extends between channel members **122** and **124** and is fixed in common with them to the gussets **132** and **134**. A similar channel member **136** extends between and is fixed to channel members **122** and **124** as well as to gusset **138**. Channel members **122**, **124**, **130** and **136** define an opening in which a horn reflector can be supported. Reinforcing angle members **140** and **142** extend from gussets **126** and **128** to gusset **138**. Channel members **144** and **146** extend from channel members **122** and **124** to gussets **148** and **150** and angle members **152** and **154** extend from gussets **148** and **150** to gussets **126** and **128**.

Gussets **148** and **150** are fixed to channel members **156** and **158** which are common to leg **120** as well as legs **116** and **118**. Angle members **160** and **162** extend from channel members **156** and **158** and are joined by angle member **164**. Angle member **164** is in turn fixed to angle members **168** and **170** and to channel members **166** and **172** which extend between it and gussets **132** and **134**. Parallel members **122–162**; **130–164**; and **124–160** are fitted with removable grating plates **174** which provide a walking surface on the platform for workmen.

Each leg of the platform **114** receives vertical support by parallel angle members **176** and **178** which extend upwardly and outwardly from the vertical support members **52** and **56** to the gussets **132** and **134**.

The perimeter of platform **114** is bounded by a safety railing **180** which is supported by posts extending upwardly from the outermost angle members.

A horn reflector **182** is shown mounted in the opening in leg **116**. No reflector is mounted in leg **118**. Accordingly, the opening is shown covered by removable gratings **184** and **186**.

Lower platform **114** is permanently fixed to the tower **10** and would be constructed with such a tower regardless of the number of reflectors to be supported by it.

Referring now to FIGS. 5 and 6, there is shown a detailed view of the tower structure. The primary tower support is provided by vertical support members **52**, **54** and **56** which are preferably 3¼ inch diameter solid steel rods bolted together in 25 foot lengths as shown in FIG. 7. A flange **188** is welded to the lower vertical member **54*a*** and a flange **190** is welded to the upper vertical member **54*b***. The flanges **188** and **190** are spaced approximately ⅛ of an inch away from the end surface of the vertical members **54*a*** and **54*b***. Thus, a gap **192** of approximately ¼ of an inch appears between the flanges **188** and **190** when the vertical members **54*a*** and **54*b*** are brought into abutment. Four bolts **194** hold the flanges **188** and **190** together. The advantage of providing a gap between the flanges is so that the vertical members **54*a*** and **54*b*** can be held tightly together when the bolts **194** are drawn up.

Gusset plates are welded at regular intervals along the length of the vertical members **52**, **54** and **56**. In the preferred embodiment, the 25-foot vertical sections have sets of gusset plates mounted at each end and at intervals of six feet three inches. Typical sets of gussets are illustrated in FIGS. 5 and 6. Each set of gussets includes two plates **196** and **198** welded to the vertical members so as to define an angle of 60° betwen their planar surfaces. Typical sets of gussets including gusset plates **196**, **198**, **200**, **202**, **204**, **206**, **208**, **210**, and **212**, **218** are illustrated in FIGS. 5 and 6.

Cross members are provided at each level defined by the three sets of gussets. As shown in FIGS. 5 and 6, the cross members are designated by the numerals **216**, **218** and **220** at one level and by the numerals **222**, **224** and **226** at the next higher level.

Each cross member consists of a pair of angle pieces **228** and **230** bolted back-to-back on either side of a gusset plate. Thus, the angle pieces **228** and **230** shown in FIG. 6 are bolted at their ends to the gusset plates **196** and **200** and with their dependent angle plates at the top and extending laterally outward. The cross members are thus assembled to provide lateral internal support for the vertical members **52**, **54** and **56**.

Extending diagonally between each two sets of gussets are crossed tension rods to truss the tower and provide the necessary rigidity. FIG. 5 illustrates the manner in which the tension rods are positioned. Thus, tension rod **232** is bolted to gusset **196** and extends diagonally to gusset plate **208**. Similarly, tension rod **234** is bolted to gusset plates **200** and **204**. In a similar manner, identical tension rods extend between gusset plates on each side of the tower as defined by the vertical members **52**, **54** and **56**. Each tension rod is locked to its mate by a locking device **238**. Such locking devices are conventional. One such device is readily obtained in a market under the name "Wrap Lock."

As shown in FIG. 1, the wave guides **28** and **30** depend downwardly from the microwave horns **24** and **22**. In accordance with the principles described herein, the wave guides for each of the horns are unsupported except at the horns and at the bridge **34**. Intermediate of these support points, the wave guides are merely restrained by the wave guide restrainers **32**. One such wave guide restrainer **32** is illustrated in FIG. 8. As shown, the restrainer **32** includes a collar **240** which is clamped to the vertical support member **54** by bolts (not shown). An arm **242** is welded to the collar **240** and extends laterally therefrom. An extension arm **246** is bolted to arm **242** by bolts **248** which extend through slotted holes so as to provide adjustment for the overall combined extension of arms **242** and **246**.

A cylinder **250** is fixed to the distal end of arm **256** by means of a releasable wire clamp **252**. Cylinder **250** is flared at its end as shown.

The wave guide **30**, whose outer diameter is substantially smaller than the inner diameter of cylinder **250** passes through it and is loosely restrained thereby.

As shown in FIG. 1, the wave guide restrainers attached to the vertical support members **52, 54** and **56** are positioned at every other level of cross arms. The amount of the lateral extension for the wave guide restrainers **32** is dictated by conventional electronic principles for wave guides. The principles for correctly arranging the curvature of the wave guide are well known and therefore need not be discussed in detail. However, the use of adjustable wave guide restrainers permits the curvature to be precisely adjusted so as to obtain maximum transmission efficiency.

As illustrated in FIG. 1, and also in FIG. 5, the guy wires are bolted to gussets **254** which are welded to the vertical support members **52, 54** and **56**. Intermediate the terminal socket **258** on each guy wire and the gusset **254** is a saddle member **256**. Saddle member **256** comprises a pair of spaced apart side pieces **258** and **260** which are fixed in position by top and bottom plates **264** and **266** that are welded thereto. The spacing between side pieces **258** and **260** is substantially wider than the width of one of the wave guides such as wave guide **28**. Thus, the wave guides can extend freely along the length of the tower defined by the vertical support members without interference with the guy wires.

Saddle member **256** is connected to the terminal socket **258** and gusset **254** by pins **270** and **268** which extend therethrough and are held in position by cotter pins or the like.

The foregoing describes the means for supporting and restraining the wave guides which depend from microwave horns mounted on the uppermost platform. As explained above, the uppermost platform legs **40, 42** and **44** extend outwardly from the apices of the triangle defined by the vertical support members **50, 52** and **56**. On the other hand, the legs for the lower platform **114** extend outwardly from a point intermediate the sides of the triangle defined by the vertical support members **52, 54** and **56**.

To guide and restrain the wave guides which depend from the horns mounted on the lower platform **114**, a support has been provided at every other level of cross members.

One such support is illustrated in FIG. 5 wherein three angle members **272, 274** and **276** are shown mounted on the cross members **216, 218** and **220**. The angle members **272, 274** and **276** are mounted so as to define a triangle with its apices extending from and disposed intermediate the sides of the triangle defined by the cross members **216, 218** and **220**. Stated otherwise, the apices of the triangle defined by the angle members **272, 274** and **276** define an included angle of 60° with the apices defined by the cross members **216, 218** and **220**.

As best shown in FIG. 6, angle members **272, 274** and **276** are joined at their apices by braces **278** and **280**. The braces extend between adjacent angle members and also serve to support the inner arm **242** for a wave guide restrainer **32**. Only the arms **242** are shown inasmuch as the remainder of the wave guide restrainers **32** which are attached to the angle members are identical with those shown in FIG. 8.

The angle members **272, 274** and **276** also serve another function. A ladder **282** is fixed to them and thereby supported within the tower structure. If desired, gratings **284** can be mounted at the various levels for providing a space upon which a workman can stand to adjust the wave guide restrainers.

In the preferred embodiment, the tower **10** is provided with a third platform **290** for supporting additional electronic reflectors if desired. In the preferred embodiment, the platform **290** is in reality three levels **292, 294** and **296** which are identical in structure and spaced approximately six feet above each other. The levels are constructed by providing a triangular shaped member attached to the vertical support members **52, 54** and **56** and then additional brace members are attached to the triangular member. The additional members define the perimeter of each platform level in the shape of a hexagon.

An additional feature of the present invention, a truss bridge structure is provided for supporting the wave guides from the tower **10** into the transmitter building **36**.

As shown in FIGS. 9 and 10, the wave guide bridge **34** surrounds the tower **10** at its base **12**. The bridge structure **34** is spaced from the tower **10** by a distance equal to the distance of the wave guides **300** from the tower. By way of example, six wave guides **300** have been illustrated as if the tower **10** were supporting six microwave horns.

The bridge **34** is supported on four braced legs **302, 304, 306** and **308** which are fixed to reinforce concrete footings **310, 312, 314** and **316**. The legs **302–308** are in the nature of truncated A frames which support the bridge trusses **318, 320** and **322** as well as the cross trussses **324. 326** and **328**.

All of the trusses are constructed of angle pieces assembled to define rectangular tunnels such as tunnels **330** and **332** in trusses **318** and **320**. As shown in FIG. 1, appropriate cross bracing is provided for maintaining rigidity in the bridge trusses. The top of each bridge truss is fitted with cover plates **334**.

Appropriate clamps for the wave guides **300** are provided to support wave guides as they extend into the opening **336** in the transmitter building **36**.

The bridge **34** provides functional rigidity for supporting the wave guides at the ground level. Although the bridge is shown as supporting only six wave guides, it is designed to support as many as twenty-four wave guides when necessary.

The foregoing description of the structural details should make the advantages of the tower **10** readily apparent. Among the advantages are the fact that the tower can be assembled in twenty-five foot sections at ground level. Thereafter, the sections can be raised and bolted into position. All elements in the tower are bolted together to further simplify the assembly and erection. Another advantage as explained before, is the modular construction that allows for the installation of a first platform for supporting three microwave horns and then a second platform for supporting an additional three microwave horns when added facilities are required.

The use of a guyed tower in communications is an additional advantage because of its economy. Moreover, the guyed tower of the present invention more than meets the necessary rigidity required in telephone communication. The structure of the present invention is capable of withstanding wind velocities of over 112 miles per hour; or stated otherwise, 50 pounds per square foot wind load. The rigidity of the tower at 20 pounds per square foot (70 m.p.h.) is as follows.

Deflection plus or minus 0.25°
Twist plus or minus 0.50°

To obtain the design specifications, the vertical support members are 3¼ inch diameter solid steel. The cross members are 2 x 2½ x 3⁄16 angle steel and the tension rods are ⅝ of an inch in diameter. All gusset plates for supporting the cross members and tension rods are ½ inch steel. The upper guy wires attached to the bottom of the lower platform have a test strength of 150,000 pounds and the lower guy wires have test strengths of approximately 80,000 pounds.

The tower is relatively light in relation to its load capacity which includes three microwave horn reflectors on the top platform and three microwave horn reflectors on the lower platform as well as a capacity for two 8 x 12 passive reflectors on the platform **290**. Each set of three horn reflectors covers a full 360°.

The present tower is designed to provide top platform heights ranging from 100 to 400 feet in multiples of 12 feet 6 inches.

The present invention may be embodied in other specific forms without departing from the spirit or essential attributes thereof and, accordingly, reference should be made to the appended claims, rather than to the foregoing specification as indicating the scope of the invention.

I claim:

1. A guyed tower comprising a base, upright vertical support members, horizontal cross members joining said vertical support members, tension rods extending diagonally between said cross members for reinforcing said tower, a first microwave horn supporting platform mounted adjacent the top of said tower, said first platform including at least two equiangularly spaced legs extending laterally from said tower, each of said legs including means for supporting a microwave horn, a removable second platform mounted above said first platform, said second platform having at least two equiangularly spaced legs extending laterally from said tower, each of said second platform legs including means for supporting a microwave horn, said second platform legs being spaced angularly intermediate said first platform legs.

2. A tower in accordance with claim **1** wherein the tower structure comprises a plurality of assembled tower sections, each section being connected by joining the vertical support members in abutting relation.

3. A tower in accordance with claim **2** wherein said individual sections comprise three vertical support members, spaced cross members extending between said support members and connected thereto, each of said cross members including a pair of angle members bolted to a gusset on said vertical members, said tension rods extending diagonally between said cross members and being bolted to said gusset on each side of said tower defined by the three vertical support members, a flange adjacent each end of each vertical support member, each said flange being spaced away from the end of said vertical support members, said vertical support members of one section being aligned in abutting relation with the vertical support members of another section, and bolts extending between adjacent flanges of adjacent sections to retain such sections.

4. A tower in accordance with claim **1** including a wave guide support bridge between said tower base and a transmitter building, said bridge including at least three longitudinal wave guide channels, and wave guide retaining means mounted within said channels.

5. A tower in accordance with claim **1** wherein said tower has three sides defined by the spaces between three vertical support members, one of said platforms being disposed with the longitudinal axis of three platform legs extending each from a vertical support member, the other of said platforms being disposed with the longitudinal axis of three platform legs extending each from the side of said tower, and a plurality of wave guide restrainers extending from the tower below each of the legs, said wave guide restrainers below said platform legs extending from said vertical support members being fixed to said vertical support members, and the wave guide restrainers below said platform legs extending from the tower sides being supported by support means extending from said cross members.

6. A tower in accordance with claim **1** including guy wires extending from said vertical support members, said guy wires being connected to said vertical support members by a saddle, said saddle including guy wire and tower connecting means disposed at opposite ends, and spaced apart side pieces connecting said guy wire and tower connecting means, said side pieces and said guy wire and vertical support connecting means defining an opening in said saddle for receiving a wave guide therethrough.

7. A tower in accrdance with claim **1** including a wave guide support bridge extending between said tower base and a transmitter building, said bridge including longitudinal wave guide channels disposed completely around said tower, and wave guide channels extending from said first mentioned channels to an opening in said transmitter building, each said channel including wave guide restraining means for retaining wave guides in said channels.

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ELI LIEBERMAN, Primary Examiner

U.S. Cl. X.R.

343—890