Sept. 2, 1958 E. F. HARRIS 2,850,735

PARABOLIC ANTENNA STRUCTURE

Filed June 19, 1956 2 Sheets-Sheet 1

Fig. 1.

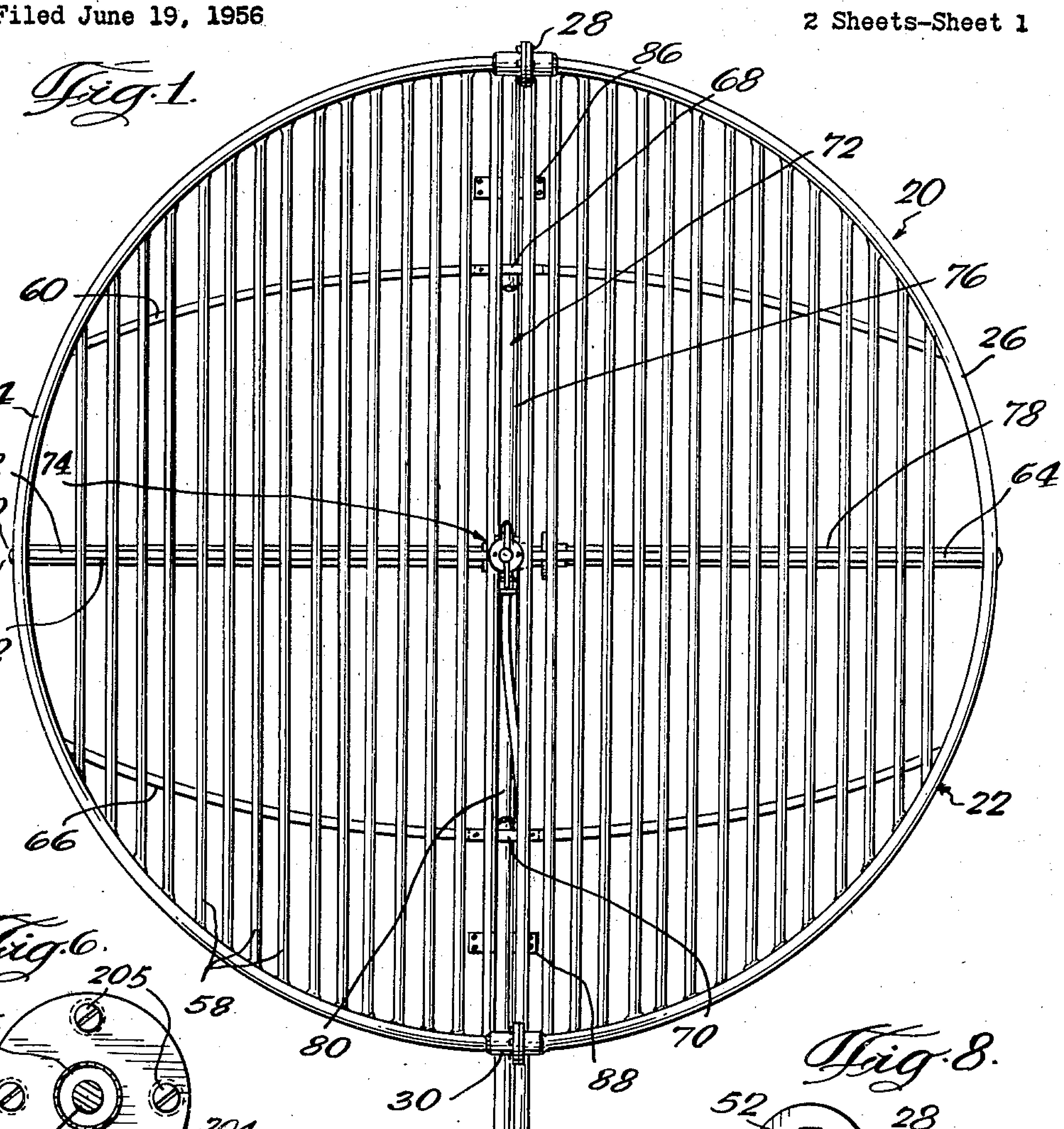
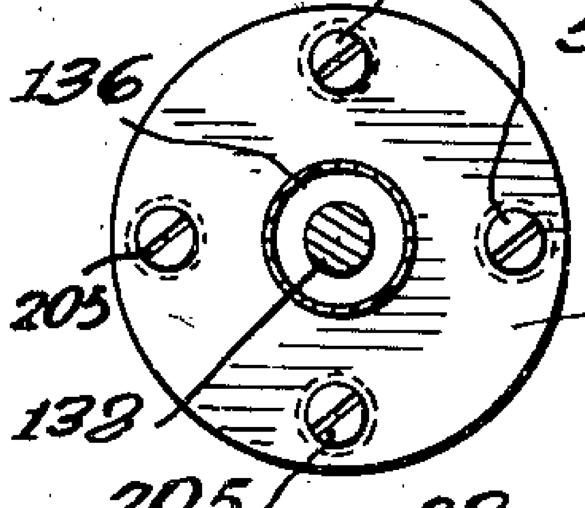


Fig. 6.



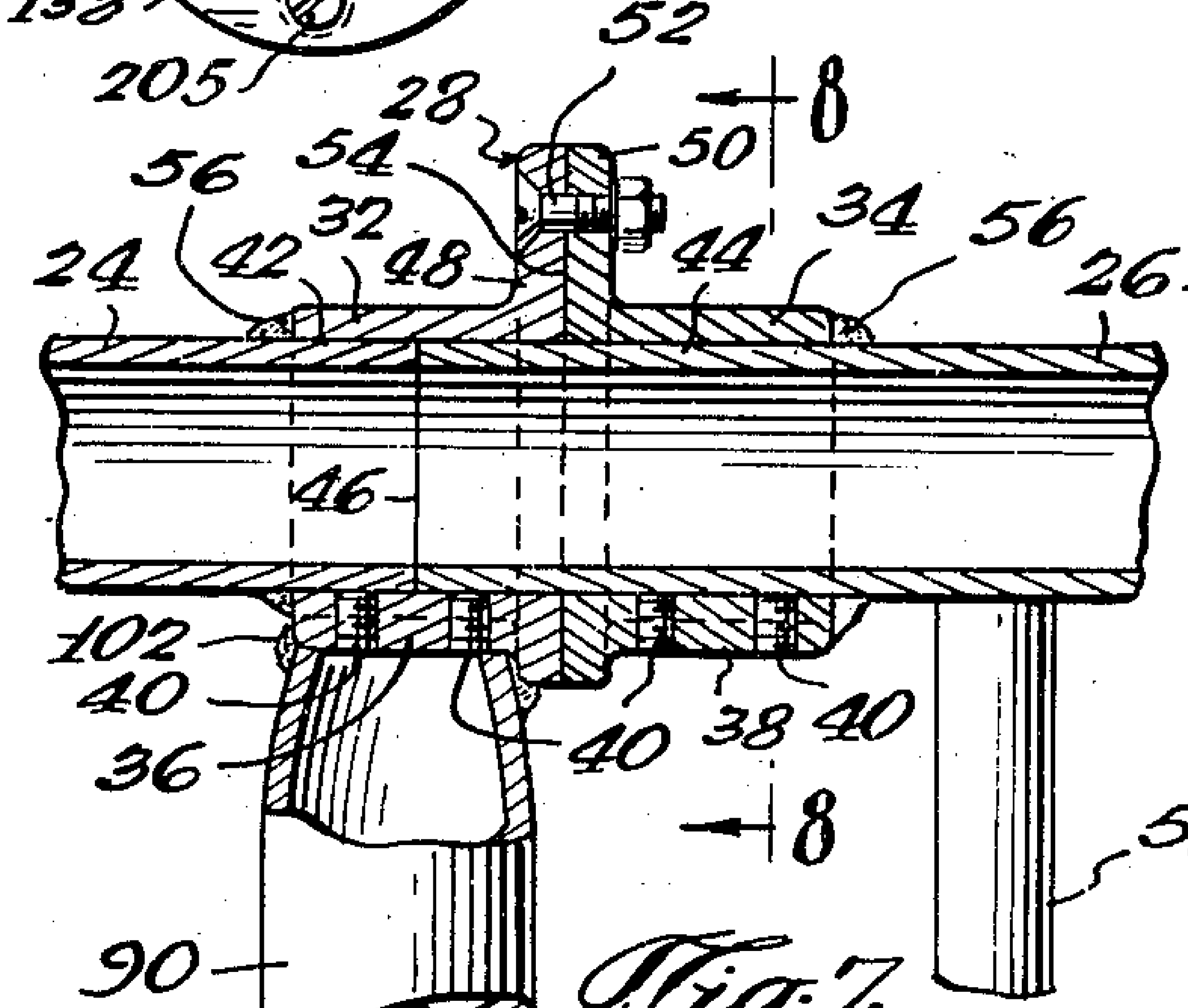
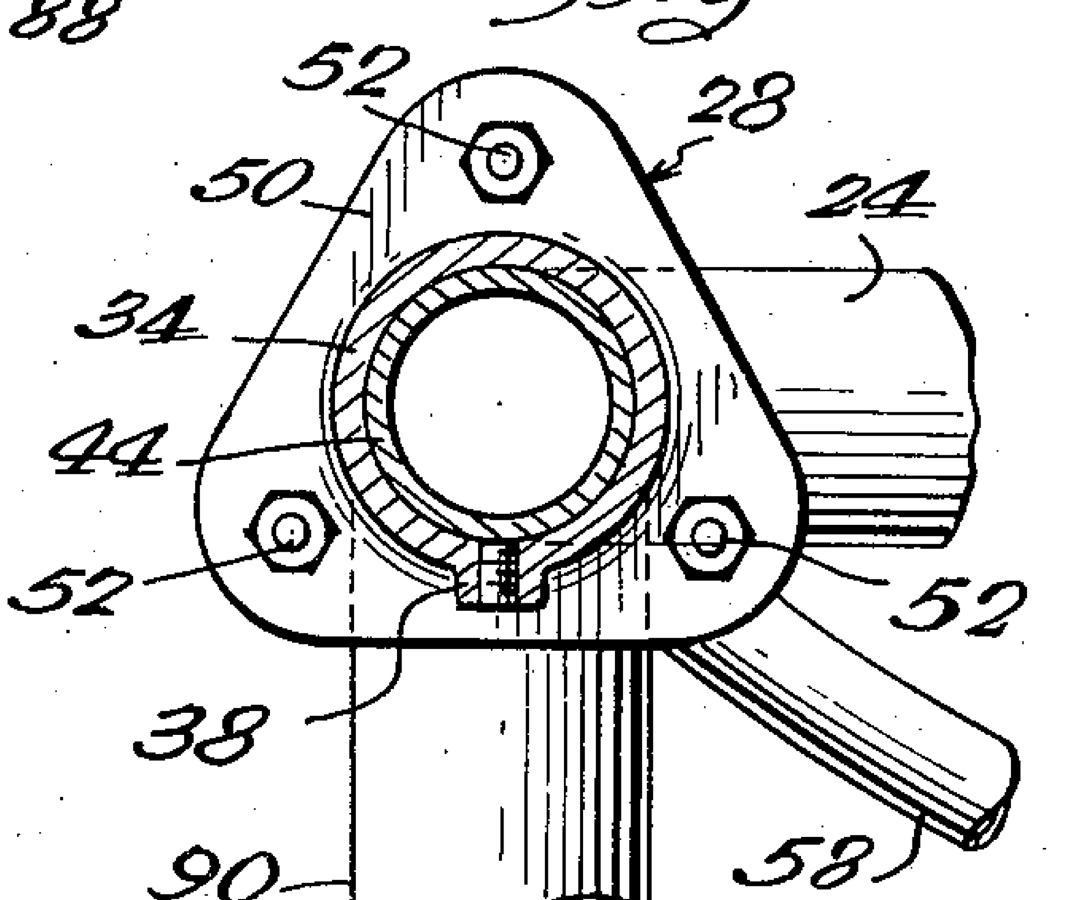


Fig. 7.

Fig. 8.



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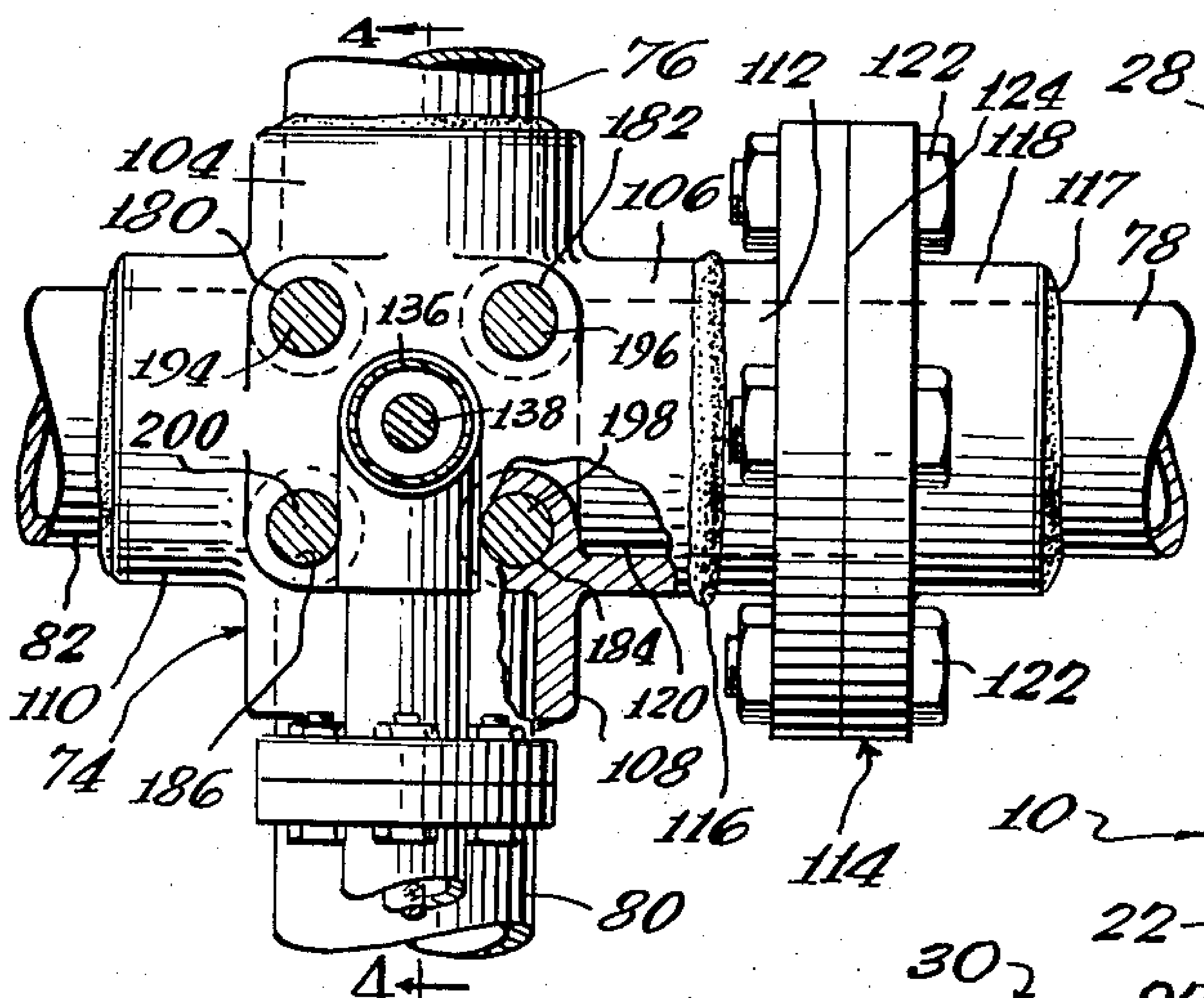

Fig. 3.

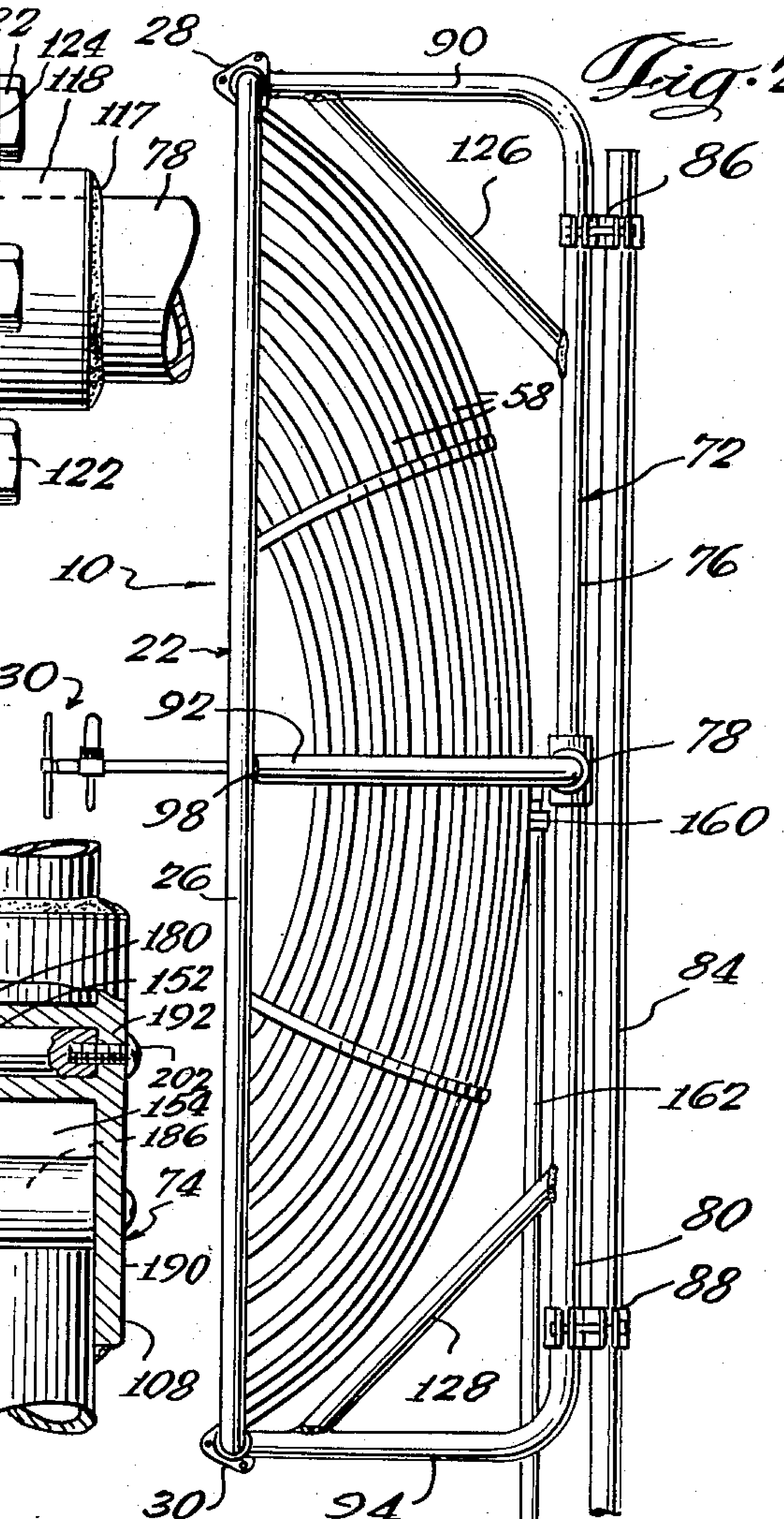

Fig. 2.

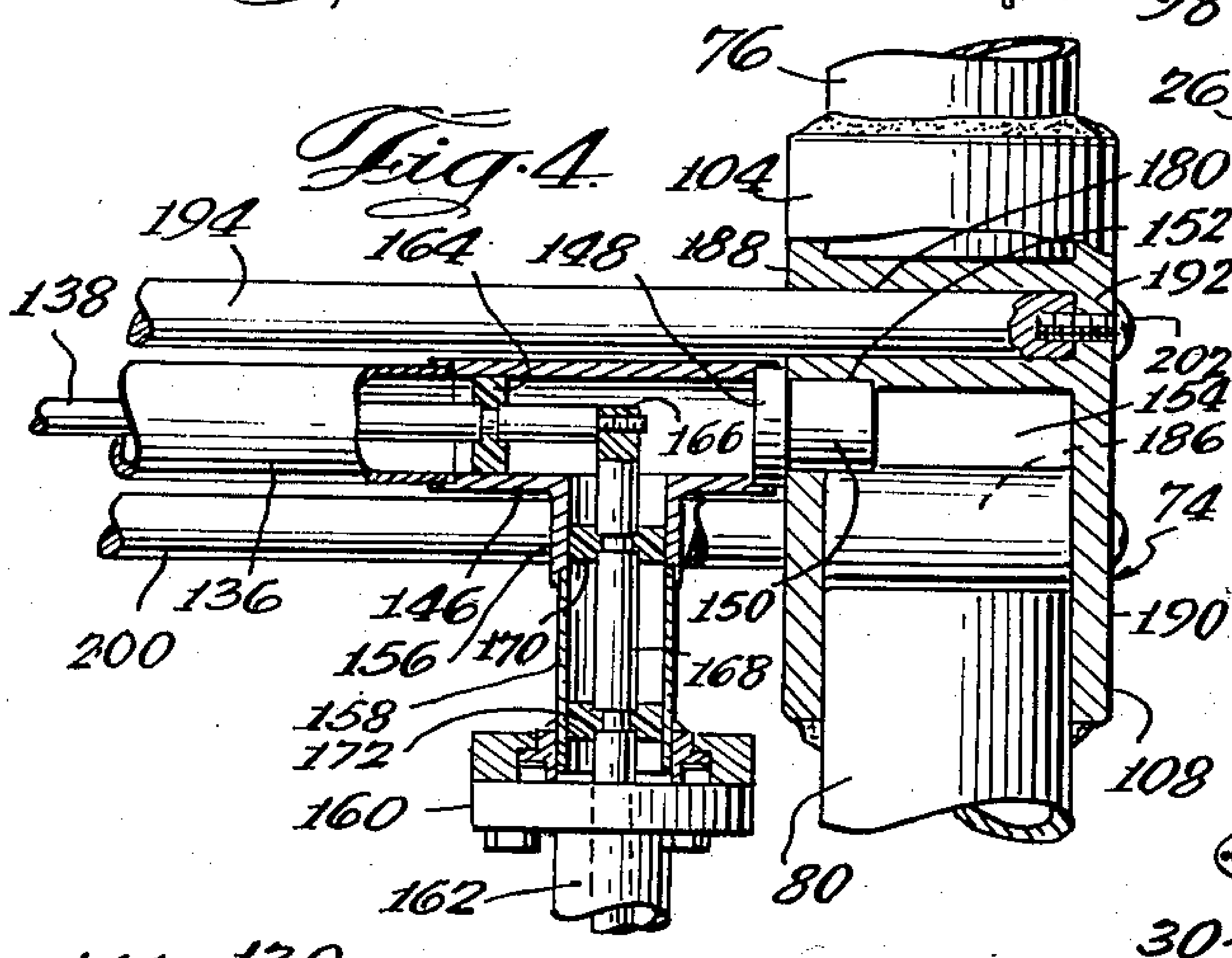

Fig. 4.

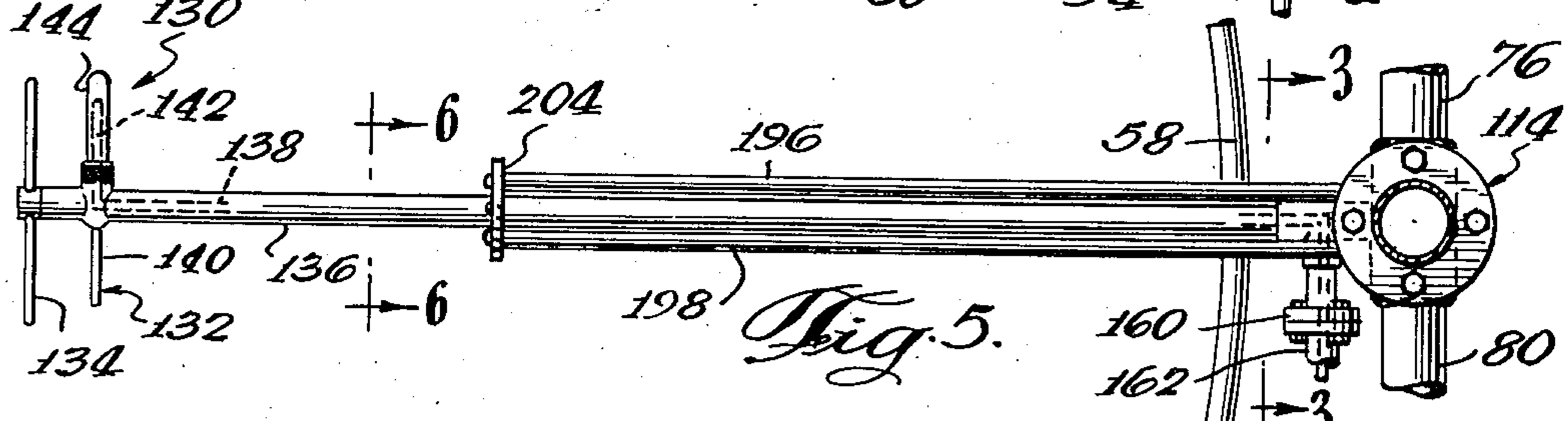

Fig. 5.

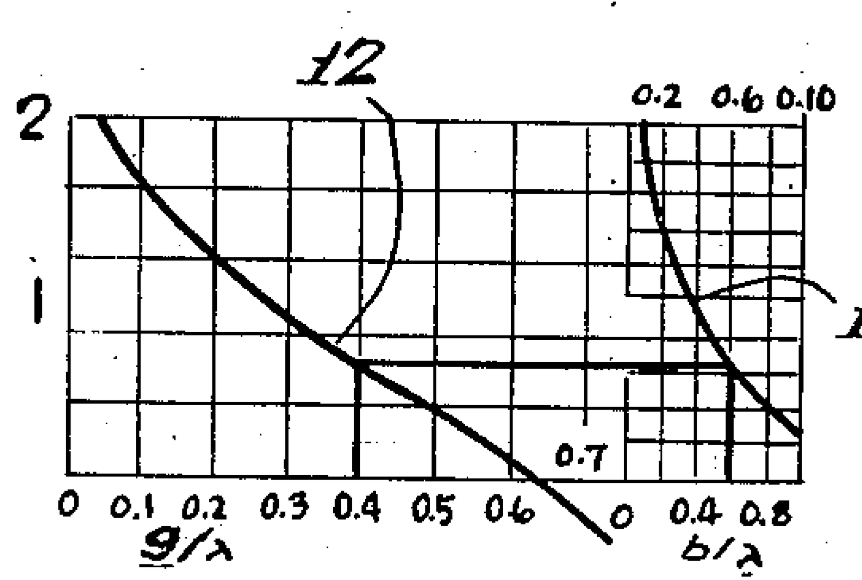

Fig. 9.

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PARABOLIC ANTENNA STRUCTURE

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Application June 19, 1956, Serial No. 592,299

17 Claims. (Cl. 343—840)

This invention relates generally to high frequency antennas and more particularly is concerned with the construction of a high frequency parabolic antenna preferably for use in point-to-point communications, although not necessarily limited thereto.

The great advantages of parabolic antennas are well known. The parabolic antenna fed at its focal point provides a high gain sharp beam with relatively low minor lobe distribution. Increasing the diameter of the parabola increases the gain of the antenna, while narrowing the beam width. Parabolic antennas are highly directional, obviously, and where the antenna is formed as a solid structure of revolution, that is, a paraboloid, the front to back ratio is so great that it may be considered that there is no back radiation pattern whatsoever.

With all of the advantages, it would appear that for point-to-point communications, for long-distance relaying of high frequency energy, and for many other purposes, the parabolic antenna is ideal. The principal difficulties with parabolic antennas as heretofore constructed are enumerated below and it will become immediately apparent that there are many reasons why parabolic antennas are not used in great numbers despite their excellent performance characteristics.

(1) Parabolic antennas which are made of sheet metal are usually spun, although they may be stamped in smaller sizes. Obviously the equipment to manufacture such antennas, and especially where large sizes are required is expensive and complex; it is difficult to handle the antennas; it is difficult and laborious to maintain proper dimensions; and the antennas are very expensive.

(2) The parabolic antenna must be fed at its focus, and the feed must be maintained at the focal point of the paraboloid with accuracy, and without vibration as might be caused by high winds prevalent at the heights and under the conditions such antennas are required to be mounted. Thus, besides the support required of the antenna itself, there must be a rigid, fixed support for the feed point. Just as an example, a six foot diameter parabola of fairly shallow dimension uses a focal length of about two feet which means that the feed dipole, pressure-tight radome, and parasitic elements must be cantilever mounted from the center of the paraboloid. A ten foot paraboloid has a focal length of approximately 40 inches. A rigid mounting for such a standard is not practical, so far as I am aware for the usual parabolic antenna, and if at all feasible would be most expensive and heavy.

(3) Antennas intended for high frequency use in communications fields are always mounted as high above the terrain as possible and hence are subjected to high winds, rains, sleet, and the like. The parabolic antenna of the solid surface type, and even the fine mesh type are subjected to enormous stress by wind and to ice build-up to an extent that larger sizes such as six feet and more have been considered impractical for many installations.

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Those installations which have large sizes require elaborate supporting structure to withstand the wind stress, and complex and expensive de-icing means to prevent icing.

(4) In connection with the latter described difficulty, the only obvious solution would seem to be to build the antenna sturdy and generously to withstand the stress, but this gives rise to extremely heavy antennas, which are difficult and expensive to install, and to mount.

An important object of the invention is to provide a novel and improved parabolic antenna structure which will overcome these disadvantages, and others not specifically mentioned.

The invention is characterized by a structure for a parabolic antenna which is formed of a plurality of parabolic contoured tubular elements arranged substantially parallel one another on a novel framework, and thereby providing grid structure which, by proper choice of dimensions, gives all of the advantageous characteristics of a dish-type paraboloid of solid surface or mesh structure, but with none of the disadvantages. The objects of the invention include the provision of such structure.

Other objects of the invention lie in the provision of novel framing means and bracing structure for the antenna whereby to support the same very efficiently, and brace the same so that its shape and contours are rigidly maintained, while enabling facile and economical assembly on a mass production or semi-mass production basis.

One of the most important objects of the invention is the provision of a novel structure for supporting the feed standard and coaxial transmission line for the antenna, which assures perfect and rigid alignment, centering and support for the feed means. Coincidentally, with this object is the provision of novel structure which, besides serving as the base and support for the feed means, also serves as a junction or coupling for framework supporting the paraboloid whereby the relationship between the feed means and the paraboloid are substantially maintained.

Additional objects of the invention are concerned with the improved electrical characteristics of the antenna, such as for example, its ability to be useful over a wide range of frequencies, notwithstanding its grid construction; its extremely high front-to-back ratio notwithstanding its grid construction; its extremely narrow beam width and high directivity notwithstanding its grid construction.

Mention must be made of several other advantages of the structure which will hereinafter be described, which are characteristic of the invention and apply to any embodiments thereof. With the width of grid spacing permissible for the frequencies at which the antenna is best usable, feeding the antenna, and mounting the same are considerably simplified.

Cables and coaxial lines are easily led and mounted with little or no spacing from the theoretical surface of revolution of the antenna. Tools are easily inserted between adjacent tubular elements for securing and adjusting mountings, brackets, joints, and the like. The rear surface bracing required in prior antennas is eliminated, and as well the need for spacing the feed rearward of the antenna is eliminated. Thus, the physical front to back overall dimension of the mounted antenna is less than for comparable antennas if they were formed of solid surface paraboloids or of mesh.

Because of the grid construction, mounting the antenna to cross arms, braces and the like is simplified since tools are easily inserted and manipulated through the antenna elements.

Although the grid construction gives rise to less likelihood of icing, it is a simple matter to de-ice the antenna of the invention by the use of heating elements along the parallel grid elements, or even by the simple use of infrared radiation applied by a lamp or the like from the rear of the antenna.

An important object of the invention lies in the provision of a parabolic antenna of parallel grid structure and tubular framing means in which the antenna is capable of ready disassembly or assembly along a plane or planes parallel with the planes of the parallel grids, whereby the antenna may be separated into segments for shipment, and additionally advantageous, may be mounted upon its standard segment by segment. In connection with this object, one segment will have the antenna central support or hub member and the feed means with its support, and may be completely installed and connected to the transmission line before the other segment or segments are secured.

Other objects and advantages will become more apparent as the description of the invention proceeds hereinafter. A preferred embodiment has been set forth in considerable detail, as required by the patent statutes, and in connection therewith the drawings illustrate the same in a manner to emphasize the advance in the arts and sciences achieved by the invention.

Those skilled in the art will understand that the invention as embodied herein is capable of wide variation, without departing from the invention or the spirit thereof. For example, although the structure is shown capable of being disassembled into two halves, it will be appreciated that under certain circumstances where the antenna can be made smaller the same will be formed as a unitary structure, or where for example, it is feasible to transport the handle a large antenna it need not be necessary to form the same into parts capable of assembly. On the other hand, the structure of the invention is advantageous in that the paraboloid can easily be made to come apart into more than two sections, as where the diameter is say of the order of fifteen feet.

The embodiment illustrated in the drawings appended hereto is a structure which was formed with a paraboloid approximately ten feet in diameter, and in the said drawings:

Fig. 1 is a front on elevational view of the antenna of the invention, mounted for simplicity of illustration to a vertical mast.

Fig. 2 is a side elevational view of the same.

Fig. 3 is a sectional view taken through the center of the antenna generally along the line **3—3** of Fig. 5 and in the direction indicated, and on a greatly enlarged scale compared to the scale of Figs. 1 and 2.

Fig. 4 is a sectional view taken through the center of the antenna, that is through the feed and framework support generally along the line **4—4** of Fig. 3 and in the direction indicated.

Fig. 5 is a side elevational view, partly in section, of a portion of the antenna showing the feed support and associated structure.

Fig. 6 is a sectional view taken generally along the line **6—6** of Fig. 5 and in the direction indicated which is inward toward the center of the paraboloid.

Fig. 7 is a sectional detailed view through a portion of the antenna showing one of the couplings by means of which the antenna is capable of being disassembled for shipment in knocked down condition.

Fig. 8 is a sectional view through the coupling of Fig. 7 along the line **8—8** and in the direction indicated.

Fig. 9 is a simple chart referred to in the explanation which follows, relating to the dimensions of the antenna.

Theoretical investigations by others have established certain dimensional requirements for the construction of grids which are intended to act substantially as perfect reflectors. In U. S. Letters Patent No. 2,530,098, issued November 14, 1950, to L. C. Van Atta, the general structure which meets this requirement is said to have the percent open area large relative to the percent area of the edges of the elements comprising the grid. Obviously, unless this is true, the structure is not economical, defeating an important purpose of the invention. Van Atta uses rectangular cross section bars or strips, which are not as desirable as the tubing of commercial dimension which is used in the instant invention, but the spacing taught by Van Atta is approximately that of the successful antennas constructed in accordance with this invention. Van Atta suggests that the spacing between adjacent bars be less than half the wave length at which the antenna is to be used, and slightly more than one quarter the wave length.

Van Atta likens a grid constructed to act as a perfect reflector to a series of wave guides designed "beyond cut-off," that is to completely attenuate energy tending to be propagated therethrough.

Another discussion of this type of grid is found in "Radio Aerials" by E. B. Moullin, Clarendon Press, 1949 in which the field on the far side of a grating is described as dependent upon the magnitude and phase of the current in each of the parallel elements by the incident wave. A solid surface is likened to a grid of an infinite number of thin wires, the value of the net field at the surface of the wires being zero. The same effect of the solid sheet is therefore achieved by making the self inductance of each element of the grid equal and opposite to the mutual inductance. Thus, if one chooses the proper radius and spacing, the impedance of the wires is purely resistive and the induced current is in phase with the inducing E vector of the incident wave, and the wave radiated from the grid or grating will be equal in magnitude and opposite in phase to the incident field—the requirements for perfect reflection.

The dimension between bars, on centers is designated g and the diameter of the bars is designated b in the graph of Fig. 9. This graph represents a mathematical relationship between the two curves **12** and **14** which enable the functions of g and b to be related to one another for different frequencies. The manner of computing the curves is generally described in the book above referred to, and is not believed required to be set forth here. In using the curve, one starts with a predetermined proportion along the base line of either part of the graph. For example one may have available a certain diameter of tubing which represents a certain value of b/λ. Let us say this is .05. Following the line drawn vertically to the intersection with the curve **14** and then horizontally over to the left to where the same line intersects the curve **12**, and then downward to the baseline, one reads the value of the spacing as 0.4 g/λ which is immediately converted into the desired dimension.

Referring now to Figs. 1 through 8, there is illustrated an antenna **20** of paraboloid construction which is formed principally of hollow tubular members of aluminum alloy, for example, welded or otherwise fastened together. A circular rim **22** defines the circumference of the antenna. The rim **22** may be formed as an integral member, or may be formed of several separable parts, depending upon the diamter. As previously mentioned, the antenna **20** which is illustrated is approximately ten feet in diameter, and its rim **22** is made up of two substantially semi-circular parts **24** and **26** coupled together by couplings **28** and **30**. In the case of lesser diameter antennas, the rim **22** may be an integral member, and in case of larger diameter antennas, the rim may be formed of more than two segments. Forming the antenna rim of parts enables the antenna to be shipped knocked down, since the support framework on such cases is also capable of being disassembled, as will become evident below.

The couplings **28** and **30** are identical, and hence only the coupling **28** need be described.

Coupling **28** (Fig. 7) has two generally cylindrical hollow bodies **32** and **34**, the internal bore of each of which is slightly greater than the outside diameter of the tubing forming the rim **22**. The bottom (or one side) of each body 32 and 34 is thickened as at 36 and 38 respectively to receive set screws 40 by means of which the coupling bodies 32 and 34 may initially be secured on the respective ends of the segments 24 and 26. These ends are designated 42 and 44 respectively and they abut at 46 at the exact center of the antenna. Each body 32 and 34 has an integral flange 48 and 50 which in this case is triangular (Fig. 8) with suitable perforations for the reception of bolts 52 or other fastening means cooperatively to maintain the coupling 28 in assembly. The face-to-face parting plane 54 of the coupling 28 is substantially offset from the parting plane 46 of the ends 42 and 44. Because of this, engaged end 42 is shorter than the body 32 by the amount that the end 44 is longer than the body 34. This provides a telescoping connection of great strength, easy assembly, and simple structure. Permanent securement of the bodies 32 and 34 to their respective ends 42 and 44 is obtained by welds 56.

One of the reasons for so offsetting the couplings 28 and 30 is to enable one of the principal support framework members to be wholly included with one part or the other of the antenna 20 during disassembly, while remaining at the geometric center of the antenna for symmetrical structure strength. The structure of the framework will be described below.

The so-called "surface" of the antenna 20 is formed of a plurality of parallel hollow aluminum tubular members 58 pre-shaped in any suitable manner by jigs, templates, bending dies, or the like so that their combined contour at the forward face antenna is a paraboloid of revolution. The spacing between parallel elements 58 and the thickness or diameter of the tubing from which same are formed are governed by the frequency at which the antenna is to be used. For example, when used at frequencies of the order of 900 megacycles per second, the tubing was chosen with ¾" diameter and the center to center dimension between elements 58 was 4 inches. The orientation of the elements 58 was vertical because of similar orientation of the feed dipole. The elements are required to be parallel with the E-vector of the feed device.

The two parts of the antennna 20 separate along a plane parallel with the elements 58 and hence approximately half of the number of elements 58 will be included with each of the separated parts. The opposite ends of each element 58 are welded or otherwise secured to the inside circumference of the rim 22. Although not necessary in all cases, transverse support straps 60, 62, 64 and 66 are welded across the back of the "surface" with welds at all or a substantial number of cross-over points. The size and positions of these straps is immaterial so long as they do not change the front contour of the elements 58. The top and bottom straps 62 and 66 have separable joints 68 and 70 at their respective centers to enable disassembly of the antenna, while the straps 62 and 64 stop short of one another to clear a fitting in the center of the support structure.

In order rigidly and sturdily to support the antenna 20 and cause the same to retain its perfect paraboloid contour, the rim 20 is mounted in a cruciform support structure or framework 72 forming a bracing cradle or spider for the paraboloid. Radiating from a central four-branch hub member designated 74, much like the spokes of a wheel, are four tubular support members 76, 78, 80 and 82. The support members are 90° apart and their axes are disposed in a plane generally parallel with the plane of the rim 22. These members, besides providing the framework of the antenna 20 also serve to enable the antenna to be supported from a mast. As a simple version of this, in Fig. 2, a vertical mast 84 is provided with split clamps 86 and 88 which are clamped respectively to the support members 76 and 80. In practically all cases the manner of support will be considerably more elaborate, but that illustrated is sufficient to indicate the function provided by the support framework 72.

Each of the support members 76, 78, 80 and 82 has its outermost end part bent 90°, all of the resulting arms 90, 92, 94 and 96 respectively extending in the same direction, and each arm terminates at and is welded to the rim 22. Obviously, the circle defined by the free ends of the arms 90, 92, 94 and 96 must be congruent with the rim 22. The arms 92 and 96 are welded directly to the segments 26 and 24 respectively at 98 and 100. The arms 90 and 94, however, are welded to the bodies 32 of the respective couplings 28 and 30 as shown at 102 in Fig. 7.

Referring now to the hub member 74 as illustrated in Figs. 2, 3 and 4, it will be noted that the four branches thereof provide hollow sockets 104, 106, 108 and 110. The support members 76, 80 and 82 engage and are welded or otherwise secured in three of the sockets 104, 108 and 110 respectively. The left half 112 of a flanged pipe coupling 114 is welded at 116 to the socket 106 and in alignment therewith. The radially inner end of the support member 78 is welded at 117 to the right hand half 118 of the coupling 114, but its free end 120 extends telescopically through the coupling 114 into the socket 106. Thus there is again provided a strong separable joint held in assembly by bolts 122. Preferably the parting plane 124 of the coupling 114 is aligned with the parting planes 54. The support members may be braced at their ends by diagonal struts such as 126 and 128 welded as shown in Fig. 2.

From the above description it can be seen that the antenna 20 may be separated into two halves, one half including the segment 24, the support members 76, 80 and 82 and the hub member 74; and the other half including the segment 26 and the support member 78. Straps and parabolic elements 58 are substantially divided. In this separation of the antenna into two halves or parts, the left part is self-supporting, but for storing and shipping purposes, temporary bracing of wooden boards or the like is preferably used for the right half.

The central hub member 74 provides several very important functions besides anchoring the framing structure 72. It also serves rigidly to mount and accurately to position the feed device for the antenna in a manner to be described.

As previously stated, the feed means must be placed accurately to establish a desired pattern and it must be continuously supported and prevented from vibrating in that position to maintain and preserve the pattern and efficiency of the antenna. The feed means may be designated generally by the character 130 (Fig. 5) and same comprises a dipole 132 and a parasitic reflector 134 both arranged to propagate an energy wave toward the paraboloid surface defined by the front of the elements 58. The feed means 130 is mounted on a standard 136 which is the outer conductor of a coaxial transmission line, the interior conductor of which is designated 138. One half 140 of the dipole 132 is metallically connected to the standard 136 and hence is grounded. The other half 142 of the dipole 132 has its interior end electrically connected to the inner conductor 138.

The entire transmission line which brings energy to be radiated by the antenna 20 to the feed means 130 is pressurized and gasketed to maintain such condition. Thus, the half 142 of the dipole 132 is contained in a housing or radome 144 of some material which is pervious to electromagnetic radiation, such as for example, synthetic resin. A commercial version utilized a material known as "Teflon" of excellent dielectric properties. The housing 144 is sealed to the opening in the end of the standard 136 through which the half 142 of the dipole 132 extends. The parasitic dipole 134 has both halves metallically connected to the standard 136.

In Fig. 4 it will be seen that the inner end of the standard is mounted in a T-coupling 146, the aligned branch having a plug **148** which has a male cylindrical guide extension **150** which is coaxial with the standard **136**. The hub member **74** is provided with a center socket **152** which is accurately formed in the hub as, for example, by milling or otherwise enlarging a recess **154** formed in the hub during manufacture thereof. Note that the recess and socket **152** are arranged normal to the plane of the support members **76, 78, 80** and **82**.

The accurate placement of the feed means **130** and the standard **136** relative to the hub member **74** means that the feed means is accurately and precisely placed relative to the paraboloid of the antenna **20** because the same member **74** provides the central and basic support for the antenna.

The angular boss **156** of the T-coupling **146** has a section of cylindrical conductor **158** mounted thereon which supports a coaxial transmission line flanged coupling **160** to which the principal coaxial transmission line **162** is secured and electrically coupled. Note that the center conductor **138** is supported in the standard **136** by beads or insulating spacers, one of which is shown at **164**. The conductor terminates at **166** in the T-coupling **146** at which point it connects with another center conductor **168** which passes through the section **158** supported by spacers **170** and **172**. Similar means are required for spacing the center conductor of the transmission line. The elaborate means for connecting the joints of the transmission line and feed standard and feed means are necessary for maintaining the pressurized condition above referred to. There is no need to expand upon the advantages of such means for feeding the antenna since these are well known. Obviously many different kinds of transmission lines could be used, and the fitting illustrated and described are capable of many variations.

The hub member **74** has four additional sockets **180, 182, 184** and **186** formed therein surrounding the socket **152** and parallel therewith. These sockets extend from the one face **188** completely through the hub member **74** and terminate just short of the opposite face **190** which is imperforate, but for screw holes passing through the resulting partitions such as the partition **192** in Fig. 4.

In casting the hub member it is obviously hollow so that the support members **76, 78, 80** and **82** may be inserted into the four branches thereof. Each of the sockets **180, 182, 184** and **186** are formed by drilling out recesses provided by suitable cores, or other casting techniques. The recess **154** is thus formed by the four columns containing the sockets **180, 182, 184** and **186**, and, as will be seen, the sockets form stop members for the insertion of the ends of the support members **76, 78, 80** and **82**. The hub member **74** could as easily be formed of a solid member and suitably drilled to form the sockets and seating recesses for the support members and the central socket for the reception of the centering extension **150**.

Each of the sockets **180, 182, 184** and **186** has an elongate support rod seated therein and permanently secured by screws passing into the bottom of the socket from the back face **190** of the hub member **74**. Thus, there are the rods **194, 196, 198** and **200** respectively engaged in the sockets held in place as by screws **202**. These rods extend a substantial distance outward of the hub member **74** parallel with and surrounding the standard **136**, and the ends thereof are secured to the bottom face of a disc **204** which is accurately brazed or otherwise permanently affixed to the standard. The securement may be by screws **205** passing through the disc **204** and into the ends of the rods. These rods provide extremely rigid and strong support for the standard **136** again from the hub member **74** which supports the paraboloid. Lateral movement of the standard **36** and the feed means **130** is eliminated by this structure.

The transmission line **162** and coupling **160** are placed very close, if not intersected by, the surface of the paraboloid formed by the elements **58**. Furthermore, in addition to the saving of front-to-back space, the entire transmission line is accessible and can be serviced without difficulty.

The antennas of the invention are well suited for frequencies between 300 and 1000 megacycles per second. Specifically, antennas of various sizes have been constructed and successfully operated at frequencies between 890 and 960 megacycles and between 450 and 470 megacycles for special purposes. The front-to-back ratio of the antennas was comparative with that of solid surface antennas. For example, on the six foot antenna, not only were the H-plane and E-plane beam widths and minor lobe structures almost identical for those of a solid surface paraboloid, but the front-to-back ratio was measured at better than 30 decibels, which is representative of good solid surface parabola design. The comparison between larger diameter antennas constructed in accordance with the invention is likewise as favorable.

The gain of the antenna over a standard dipole has been measured for six and ten foot paraboloids as 20 and 25 decibels, respectively at frequencies in the range between 890 and 960 megacycles. Note that these values are for the same grid structure, with the frequency being changed by altering the sizes of the feed elements. Thus, the antenna performs efficiently but without criticality over a practical wide range of frequencies. The 3 decibel points in the H-plane for these antennas were 10 and 7 degrees respectively, and in the E-plane were 11 and 8 degrees respectively. Again, this is practically the same as solid surface paraboloids.

The same antennas are suitable for use at half frequencies, withous change in paraboloid dimension, but of course with expected change in beam width, gain, pattern, etc.

Measurements made of typical antennas for wind thrust at 100 miles per hour showed amazingly low forces, compared with solid paraboloids. The six foot antenna had a thrust of about 250 pounds, substantially less than the thrust of a solid surface paraboloid of about one-third the area. The ten foot paraboloid had a thrust in a 100 mile per hour wind of only 700 pounds.

As previously stated, the antenna **20** illustrated represents the construction of a ten foot diameter paraboloid, and this antenna can be separated into two segments by separating the flanged couplings **28** and **30** in the circular tubular rim **22**. The couplings are offset from the geometric center of the antenna **20** so that when the resulting segments are separated, the left half (as viewed in Fig. 1) is completely self-supporting. It includes the central hub member **74** which in turn carries the tubular support members **76, 80** and **82** to which are secured the left half of the circular rim **22** and approximately half of the grid members or elements **58**. The self-supporting half also includes the entire feed means **130**, its standard **136**, support rods **194, 196, 198**, and **200** as well as the T-coupling **146** and all of the transmission line up to the flanged coupling **160**. This means that the entire left segment of the antenna can be shipped, stored, and mounted independent of the other half. The great advantages of this may be even more emphasized when one realizes that steeplejacks working high above the terrain on precarious perches need only hoist one segment of antenna to the supporting tower and completely install and connect the same. They handle a small weight and less bulk, and their installation of the remaining segment is considerably simplified. Furthermore, in cases where it is not feasible to install both segments at the same time, emergency service can be given with the installed segment, although at substantially reduced efficiency.

The structure of the antenna which permits this disassembly into parts is the provision of the couplings in the rim and support members along planes which are parallel with the grid structure. Thus, the manufacturer may provide for segmenting along any desired plane, without the need for complex structure, and without breaking up any of the paraboloic elements **58**. In the case of larger antennas, the rim may be provided with coupling links **28** and **30** spaced right and left from the center of the antenna which will enable the rim and the grid structure to be separated into three sections, for example, the center one generally rectangular, and the outer two circular elements along chords defined by the right and left sides of the center section. In this case, the cruciform framing structure will also have two couplings like **114**. The central segment will be capable of independent transportation, storing and handling, and hence suitable for independent installation. As a matter of additional advantage, in antennas having three segments, the center section will independently give excellent performance without its adjacent segments in place.

The invention has been set forth in a manner which it is believed will enable those skilled in this art to fully understand the same and be able to construct and use antennas embodying the features of the invention. The principal novelty, while especially believed to be the application of the known principles of grid reflection to a novel structure resulting in high efficiency, great economy, low weight and wind thrust, and ease of handling, fabrication, and installation, is not intended to be the only inventive concept. The invention also lies in the novel structure for supporting the antenna support members, the feed standard and the bracing for the feed standard all from a single member; the novel manner of supporting the paraboloid elements; and other features of the invention referred to above. Variations are possible without departing from the spirit and scope of the invention as defined in the claims.

What I claim is:

1. A high frequency antenna, comprising, a paraboloid formed of a circular metallic support member and a plurality of metallic members of paraboloic contour spaced apart and arranged in planes parallel one another with their ends conductively secured to the said support member, the spacing between adjacent prabolic members being substantially greater than the diameter of the members, a spider having radial support members with arms extending to one side of the plane of the spider and having the ends thereof secured to the circular support member, hub means at the center of the spider, feed means at the focus of the paraboloid, and a standard supporting said feed means mounted upon said hub means.

2. A high frequency antenna, comprising, a paraboloid formed of a circular metallic support member and a plurality of metallic members of parabolic contour spaced apart and arranged in planes parallel one another with their ends conductively secured to the said support member, the spacing between adjacent parabolic members being substantially greater than the diameter of the members, a spider having radial support members with arms extending to one side of the plane of the spider and having the ends thereof secured to the circular support member, hub means at the center of the spider, feed means at the focus of the paraboloid, and a standard supporting said feed means mounted upon said hub means, said standard including a coaxial transmission line, and the hub means having a socket accurately seating and receiving the standard therein.

3. A high frequency antenna, comprising a tubular circular rim, a plurality of metallic tubular members arranged in spaced apart parallel planes, but each of parabolic contour and proportioned to form a paraboloid within the rim, with the opposite ends connected with the rim, bracing and support means for the antenna comprising a cruciform structure having a central union at the cross-over point to the rear of the paraboloid and having extensions connected about the circumference of the rim and rigidly holding the antenna in shape, feed means supported at the focus of the paraboloid and supported by said union, and a transmission line connected to said feed means.

4. An antenna as claimed in claim 3 in which said feed means is mounted upon a standard and the standard is seated in said union extending through the paraboloid, and the transmission line includes a side branch intersecting said standard at a point spaced from said union.

5. An antenna as claimed in claim 3 in which the rim and cruciform structure are separable along at least one plane parallel with the planes of metallic tubular members, and said rim and structure have coupling means enabling such separation and reassembly.

6. A high frequency antenna of paraboloid configuration and formed of a circular tubular rim having a grid of parabolic tubular elements all in parallel equally spaced apart planes and all having their ends connected to the rim and defining a paraboloid, the spacing between planes being substantially greater than the diameter of the tubular elements, there being a central hub spaced rearward of the center of the paraboloid and having a plurality of radially extending support members secured therein, the ends of the support members being secured about the tubular rim and rigidly holding the same, a radiation energy feed at the focal point of the paraboloid, a coaxial transmission line connected to the said feed including a rigid rectilinear standard mounted on said hub coaxial with the said paraboloid and extending between a pair of tubular elements of the grid from the hub to the said feed, and said transmission line having another part connected with said standard into the side thereof at a point spaced from the hub.

7. An antenna as claimed in claim 6 in which there is an anchor member upon the exterior of said standard between the ends thereof and a substantial distance from said hub, and said hub has elongate bracing members secured thereto at one end of each extending from the hub toward the feed and disposed about the standard and having the opposite end of each secured to the said anchor member to rigidly fix the feed.

8. An antenna as claimed in claim 7 in which the bracing members comprise rods arranged parallel with the standard and the hub has sockets seating the rods and means securing the rods in the sockets.

9. An antenna as claimed in claim 6 in which the standard has a mounting extension on the inner end thereof and the hub has a socket for receiving the extension therein.

10. A high frequency antenna comprising a circular tubular rigid metallic rim, a plurality of tubular members of lesser diameter than the rim having their ends metallically connected across the rim and each tubular member being of a parabolic contour of size and shape such as to provide a general paraboloid shape within the rim, the tubular members lying in parallel planes spaced apart a distance substantially greater than the diameter of the tubular members to provide a grid, antenna feed means at the focal point of said paraboloid and having polarization parallel with the planes of the said grid, a combined standard and coaxial transmission line having the feed means on the end thereon arranged coaxial with the axis of the said paraboloid and extending through the grid at the rear of the paraboloid, and means supporting the said rim and standard.

11. An antenna as claimed in claim 10 in which the last means comprises a spider having a plurality of rigid arms radiating from a central junction member with the ends of the arms connected to the rim and the standard secured to the central junction member.

12. An antenna as claimed in claim 10 in which the last means comprises a spider having a plurality of rigid arms radiating from a central junction member with the ends of the arms connected to the rim and the standard secured to the central junction member, and a plurality of rigid support braces also mounted on said central junction

member and extending forwardly thereof with their ends attached to the standard to support the same.

13. In a paraboloidal antenna formed as a rim having a plurality of grid members therein, and there being a feed at the focal point of the paraboloid and a standard supporting the feed, means for establishing and maintaining constant the dimensional relationship between the feed and the grid comprising a four-way union having radial sockets and four rigid supporting members mounted in the said sockets and extending radially outward thereof, extensions on the ends of the support members secured about the circumference of the rim and rigidly holding the same in its contours, socket means centrally of the union normal to the plane of the four rigid support members and the standard being secured in said socket means.

14. In a paraboloidal antenna formed as a rim having a plurality of grid members therein, and there being a feed at the focal point of the paraboloid and a standard supporting the feed, means for establishing and maintaining constant the dimensional relationship between the feed and the grid comprising a four-way union having radial sockets and four rigid support members mounted in the said sockets and extending radially outward thereof, extensions on the ends of the support members secured about the circumferences of the rim and rigidly holding the same in its contours, socket means centrally of the union normal to the plane of the four rigid support members and the standard being secured in said socket means, second socket means parallel with said last mentioned socket means, and bracing rods secured in said second socket means and extending substantially parallel with said standard and secured thereto at places spaced from said union.

15. A high frequency antenna, comprising a plurality of metallic elements arranged in spaced apart planes but of parabolic contour to form thereby a parallel grid paraboloid, the diameter of the elements being substantially greater than the spacing between elements, frame means supporting the paraboloid and mantaining the contour thereof, high frequency energy feed means supported by said frame means at the focus of said paraboloid and energy transmission means connected therewith, said frame means having separable couplings to enable separation of the paraboloid between adjacent parallel metallic elements into at least two independent segments.

16. An antenna as claimed in claim 15 in which one segment includes sufficient of said frame means to be mechanically self-supporting and capable of independent mounting.

17. An antenna as claimed in claim 15 in which one segment includes sufficient of said frame means to be mechanically self-supporting and capable of independent mounting and also has said feed means and energy transmission means whereby to enable independent electrical connection of said one segment with an antenna energizing system.

No references cited.