(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 196 734**
A2

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **86300149.1**

(22) Date of filing: **10.01.86**

(51) Int. Cl.⁴: **H 01 Q 19/19**
H 01 Q 15/16

(30) Priority: **31.05.85 US 740241**
28.03.85 US 717514

(43) Date of publication of application:
08.10.86 Bulletin 86/41

(84) Designated Contracting States:
AT BE CH DE FR GB IT LI LU NL SE

(71) Applicant: **Satellite Technology Services, Inc.**
2310 Millpark Drive
Maryland Heights Missouri 63043(US)

(72) Inventor: **Rothbarth, James N.**
11880 Conway Road
St. Louis Missouri 63131(US)

(72) Inventor: **Smith, Edward W.**
429 Cottage Grove
Lake Arrowhead California 92352(US)

(72) Inventor: **Rahmat-Samii, Yahya**
2450 E. Del Mar Blvd.
Pasadena California 91107(US)

(72) Inventor: **Imbriale, William Anthony**
320 Starlane Drive
LA Canada California 91011(US)

(72) Inventor: **Galindo, Victor**
3221 Emerald Isle Drive
Glendale California 91206(US)

(74) Representative: **Abbie, Andrew Kenneth et al,**
A.A. THORNTON & CO. Northumberland House 303/306
High Holborn
London, WC1V 7LE(GB)

(54) **Cassegrain antenna for TVRO application.**

(57) An antenna is of the Cassegrain type with a main reflector, subreflector and horn, all circularly symmetric. The horn is corrugated and profiled with the near field focal point of the feed deep within the horn. The main reflector and subreflector are shaped in accordance with the horn pattern to optimize the energy distribution over the aperture of the main reflector. The subreflector, horn, and superstructure of the main reflector may all be of plastic molded construction.

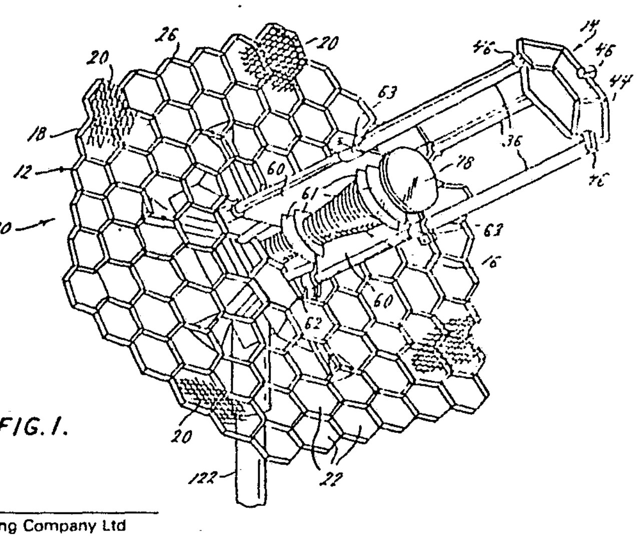


FIG. 1.

Croydon Printing Company Ltd

CASSEGRAIN ANTENNA FOR TVRO APPLICATION

This invention relates to an antenna of the Cassegrain type, and utilizes the near field focal point of the subreflector to represent the phase and amplitude origin for shaping the main reflector and subreflector. The invention further utilizes a corrugated, profiled horn, the wall of which is generally S-shaped in longitudinal cross section, and both the main reflector and subreflector are "shaped" in accordance with the horn pattern to optimize the energy distribution over the aperture of the main reflector to provide a high gain, high efficiency antenna. The antenna of the present invention is particularly designed as a television receive only (TVRO) antenna and more specifically for use as a C-band antenna, although many of its design characteristics can be used with other antennas, for other uses, and at other frequency bands such as, for example, Ku-band.

Cassegrain antennas are widely known for military and commercial use, but heretofore the advanced engineering techniques and extraordinarily expensive design methods inherently required to produce an efficient Cassegrain antenna have made such antennas impractical for TVRO use. This invention has succeeded in employing such techniques and methods while providing a highly efficient true Cassegrain antenna that can be mass produced and sold at a reasonable price, thus making it practical as a TVRO antenna, or otherwise as a transmitting or receiving antenna.

The antenna of this invention is a true Cassegrain. It includes a main reflector, subreflector, and horn. The horn is aimed toward the subreflector such that energy through the aperture of the main reflector is directed to the subreflector and then to the horn. The main reflector, subreflector, and horn are symmetrically oriented about the antenna axis (circularly symmetric), with the near field focal point of the feed lying on the axis.

The invention utilizes a corrugated, profiled horn where the wall of the horn in longitudinal cross section is generally S-shaped. The corrugations and shaping provide substantially equal E and H plane feed patterns over a broad band width at a low VSWR, low cross-polarization, and a good spherical phase pattern down to a low energy level. The antenna is a near field design with the near field focal point of the feed deep within the horn. The antenna is "dual shaped" such that the subreflector and main reflector are shaped in accordance with the horn pattern to provide substantially uniform energy distribution and high efficiency. The near field design and profiled horn allow use of a much smaller subreflector placed substantially closer to the main reflector than is otherwise possible.

The antenna of this invention utilizes a large F/D ratio, preferably in excess of .5, to provide low crossed-polarization and economy of labor and materials in making the main reflector. The subreflector and main reflector are shaped to provide nulls in the radiation pattern in accordance with satellite spacings every two degrees.

Major portions of the antenna are uniquely constructed of molded plastic to greatly reduce the cost. These portions include the horn, and the superstructure of the main reflector, and may also include the subreflector.

The result is a Cassegrain antenna which incorporates the most sophisticated design techniques and which is highly efficient and can be mass produced at low cost.

Description of the Drawings

Figure 1 is a perspective view of a Cassegrain antenna of the present invention;

Figure 2 is a side elevation view of the antenna of Figure 1;

Figure 3 is a view in section taken generally along the line 3-3 of Figure 2;

Figure 4 is a view in section taken generally along the line 4-4 of Figure 3;

Figures 5 and 6 are perspective views of extender panels for the main reflector of the antenna of the present invention;

Figure 7 is a view showing the central panel and petal configurations that comprise the superstructure of the main reflector;

Figure 8 is a view similar to Figure 7 and showing optional extender panels, including those shown in Figures 5 and 6, for the main reflector;

Figure 9 is a schematic diagram showing the geometry of a Cassegrain antenna of the present invention; and

Figure 10 shows principal and cross-polarization radiation patterns for an antenna of the present invention.

Detailed Description of a Preferred Embodiment

With reference to the drawing, there is shown a true Cassegrain antenna 10 of the present invention. While the antenna of this invention is preferably a C-band TVRO Cassegrain antenna, in a broader sense many of the same design characteristics may be used to varying degrees with other types of antennas, for other uses, and for other frequency bands.

The antenna generally includes a main reflector 12, a subreflector 14, and a horn 16, all of which are circularly symmetric. The main reflector 12 includes a superstructure 18 with a mesh covering 20 on the reflective side thereof (Figures 3 and 4). The superstructure 18 is of a honeycomb configuration having a large number of openings 22 of hexagonal shape. The main reflector has a central panel 24 symmetric about its center, and a multiple of generally triangular panels or petals 26 extending radially from the central panel. The petals 26 are identical and are attached at their inner ends at the periphery of the central panel 24. Each petal is also attached at its side edges to the side edges of adjacent petals. The central panel and each of the petals is double curved such that when assembled there is provided a smoothly shaped superstructure with a hexagonal perimeter as shown in Figure 1.

Optionally, there are provided extender panels which may be either of the configuration shown at 30 or the configuration shown at 32 of Figure 8. The extender panels effectively increase the aperture of the main reflector and are also of a honeycomb configuration as with the central panel and petals. The extender panels are attached at the perimeter of the petals, and depending on the configuration of the extender panels used, the resultant main reflector may have a circular perimeter (extender panels 30) or a hexagonal perimeter (extender panels 32). The main panel, petals, and extender panels are all formed of plastic by injection molding. With each of these extender panel designs, the subreflector may be changed to optimize the increased aperture of the main reflector, and is positioned a nominal two inches (5.08 cm) further away from the main reflector. Even with the same subreflector, the antenna's performance is improved as the extender panels act as noise shields.

The mesh covering 20 is of die-cut aluminum, flattened, and powdered coated and with a weather protective coating of polyester. The mesh covering is attached to the superstructure by suitable fasteners 34. Alternately, the mesh may be of molded plastic and plated with copper and nickel to provide the reflective surface.

To support the subreflector and horn, three equilaterally spaced spars or rods 36 extend from within openings 37 in the main panel 24 and forwardly at the reflective side of the main reflector. Each spar has a round portion 38 and an outer flattened portion 40. At the outer ends of the spars is mounted the subreflector 14. The subreflector 14 may be of one piece plastic molded construction having a smoothly shaped reflective surface 42 facing the main reflector with reinforcing ribs 44 at the side of the subreflector opposite the reflective surface. The central portion of the subreflector functions as a vertex plate for low VSWR and minimum blockage effect by the subreflector. The vertex plate is an integral part of the subreflector so that optically no energy is wasted by unnecessary scattering from the subreflector. The subreflector includes cap portions 46 that fit over the ends of the spars and are attached thereto for mounting the subreflector at the outer end of the spars and spaced away from the main reflector. The spars may be of aluminum. Alternately, the subreflector may have a circular perimeter, rather than hexagon as shown, and may be of spun or stamped aluminum with a protective coating.

The horn 16 extends through the center of the central panel 24 of the superstructure toward the subreflector with the mouth of the horn facing the reflective surface 42 of the subreflector. The horn is a corrugated, profiled horn. It has a throat portion 50 and a mouth portion 52 of larger diameter than the throat, each of which are of a stove pipe or generally straight configuration. Between the throat and mouth portions is a curved intermediate portion 54. The transitions between the throat, intermediate, and mouth portions, are smooth such that the shape of the horn wall viewed in longitudinal cross section as in Figure 4 is generally S-shaped. The horn is circularly symmetric about its longitudinal axis and is corrugated as shown substantially along its entire length.

At the throat end of the horn are wing clamps 56 for connecting a wave guide 58. The horn has equilaterally spaced radial webs 60 extending outwardly from the horn wall to the spars 36. Also near the throat and mouth of the horn are horizontal webs 61 and ring clamps 62 and 63 that clamp onto the spars to support the horn. The horn also includes rearwardly extending flanges 64 for connecting the horn to the central panel 24 of the superstructure with fasteners 65. Slots 66 allow axial adjustment of the horn.

The horn is made of three identical longitudinal sections. Hence, with reference to Figures 3 and 4, each section includes a wall portion 67 representing one-third of the horn wall; two radial web portions 68 each representing half a web 60; horizontal web portions 69 representing one-third of the horizontal webs 61; half ring portions 70 and 71 at the outer edge of each radial web portion and representing half the ring clamps 62 and 63, respectively; half flange portions 72 each representing half a flange 64; and ears 74 each representing half a wing clamp 56. Each horn section, including the wall portion, half web portions, half ring portions, half flange portions, and ears, is of one piece molded construction. The three sections are joined, such as by solvent welding, to form the horn.

The inner surface of the horn and reflective surface 42 of the subreflector are of an electromagnetic conductive material which may comprise a first coating of copper and an outer coating of nickel. These coatings may be forty-millionths and ten-millionths, respectively. The horn and subreflector are then both painted with a weather protective coating such as polyurethane. The horn also includes a weather cap 78 of an electromagnetic energy transparent material.

It should be noted that the horn being clamped to the spars helps to stabilize the spars and hence strengthen and stabilize the reflector support, all within the shadow of the subreflector for minimum blockage. The main reflector, subreflector, and horn are supported by a spider 80 secured to the nonreflective side of the main reflector. The spider has a central portion 82 with a hexagonal opening therein, and radial arms 84 extending outwardly therefrom. The spider has a shape that conforms to that of the superstructure. The superstructure is mounted to the spider by means of fasteners 86 which extend through holes in the spider and holes 88 in the central panel 24 and holes 90 in the petals 26. The spars 36 extend through openings 91 in the spider. The spider has portions 92 with arcuate surfaces 94 to define a track for declination adjustment.

A generally U-shaped connector 100 is located rearwardly of the spider and has a pivot pin 102 extending therethrough. Mounted on the pivot pin outwardly of each end of the U-connector is a spider pad 104. These spider pads have arcuate surfaces 106 that mate with the arcuate surfaces 94.

At the rear side of the U-connector 100 is an azimuth drive assembly 110 including a worm drive and housing 112, the housing of which captures the U-connector 100, and an annular gear track 114 surrounding the U-connector with the ends of the track mounted at 116 to the central portion of the spider. Thus, the combination of the annular track and worm drive housing hold the U-connector and spider pads in place so that the arcuate surfaces 106 of the spider pads engage the arcuate surfaces 94 of the spider.

A pivot yoke 120 is mounted at the upper end of a mast 122 with the top of the yoke pivotally mounted at 124 near the bottom of the U-connector and rearwardly of the pivot pin 102. A threaded rod 126 extends through a sleeve 128 pivotally mounted at the bottom of the pin 102 with the end of the threaded rod pivotally connected near the lower end of the yoke. Suitable adjusting nuts 130 allow adjustment of the threaded rod to provide an elevation adjust for the antenna. Azimuth adjust is provided by the drive 110 which pivots the spider and all the components mounted thereto, as well as the spider pads, about the axis of the pin 102. Declination adjustment is provided by positioning the spider relative to the spider pads along the arcuate surfaces.

Thus, it can be seen that the horn is held in a selected axial position by the fasteners 65, and the subreflector is held in a selected axial position by the fact that it is mounted to the spars 36 which in turn are held in a fixed axial position by the horn which is clamped to the spars. Hence, the horn and subreflector may each be axially adjusted independently of the other. Once the horn is properly positioned, the subreflector may be positioned by loosening the clamps 62 and 63 and sliding the spars in or out as desired of the openings 38 and 91 in the superstructure and spider.

Many of the structural features of the antenna of this invention are described in greater detail in co-pending U.S. applications, the entirety of all of which is incorporated herein by reference, and are further identified as follows:

Method and Apparatus for Attaching Mesh to Antenna Dish Panels, Serial Number 717,224, Filed March 28, 1985;

Antenna Dish Reflector Kit, Serial Number 717,499, Filed March 28, 1985;

Antenna Dish With Honeycomb Construction, Serial Number 717,890, Filed March 28, 1985;

Improved Cassegrain Antenna Construction for TVRO Application, Serial Number 717,504, Filed March 28, 1985;

Extender Panel Kit For Antenna Dish Reflector, Serial Number 717,502, Filed March 28, 1985;

Fastening Means For Assembling An Antenna Dish Reflector Kit, Serial Number 717,503, Filed March 28, 1985;

Antenna Dish Reflector With Integral Declination Adjustment, Serial Number 717,506, Filed March 28, 1985;

Antenna Dish Reflector With Integral Azimuth Track, Serial Number 717,498, Filed March 28, 1985;

Azimuth Track and Drive For Antenna Dish Reflector, Serial Number 717,501, Filed March 28, 1985;

Mesh Design for Antenna Dish Reflector, Serial Number 717,891, Filed March 28, 1985;

Plated Plastic Injection Molded Horn for Antenna, Serial Number 717,500, Filed March 28, 1985;

Dual Communication Link for Satellite TV Receiver, Serial Number 717,225, Filed March 28, 1985;

Figure 9 is a schematic diagram showing the geometry of the Cassegrain antenna 10 where:

140 is the near field focal point;

142 is the antenna axis Y which is the Y axis for the main reflector, horn, and subreflector;

X1 is the X axis of the main reflector;

X2 is the X axis of the subreflector;

A is the coordinate X1 = 0, Y = 0 for the main reflector;

B is the coordinate X2 = 0, Y = 0 for the subreflector;

C is the coordinate Y = 0 for the horn;

144 is the aperture plane of the main reflector;

r1 is 51 inches (129.54 cm) which is the radius of the aperture;

r2 is 11 inches (27.94 cm) which is the radius of the subreflector of a circular perimeter configuration;

r3 is 57 inches (144.78 cm) which is the radius across the long dimension of the hexagonal shaped main reflector;

r4 is 69 inches (175.26 cm) which is the radius of the main reflector with the extender panels;

146 is that portion of the main reflector outwardly of the aperture and represent ing a noise shield;

a is 43° 11', which is the angle between the antenna axis and a straight line drawn between the edge of the aperture and edge of the subreflector;

b is 13° and is the angle between the antenna axis and a line drawn from the focal point 140 to the edge of the subreflector;

d1 is 11.221 inches (28.501 cm) which is the distance along the antenna axis from the vertex of the main reflector to the aperture plane;

d2 is 39.913 inches (101.379 cm) which is the distance from the aperture plane to the vertex of the subreflector;

d3 is 2.497 inches (6.342 cm) which is the distance along an axis parallel to the antenna axis between the antenna aperture plane and the perimeter of the main reflector at the long dimension;

L1 is 13.405 inches (34.405 cm) which is the distance from the aperture plane to the mouth of the horn;

L2 is 18.405 inches (46.748 cm) which is the distance from the focal point to the mouth of the horn;

148 represents the optional extender panels.

With reference particularly to Figure 9, attached hereto as Appendix A are the X1, Y coordinates for the shaping of the main reflector including the extender panels; attached hereto as Appendix B are the X2, Y coordinates for the shaping of the subreflector, one set for a 43 inch (109.22 cm) radius optical edge, and another set for a 44 inch (111.76 cm) radius optical edge; and attached hereto as Appendix C are inside and outside radii versus Y axis coordinate for the shaping of the horn. The overall length of the horn is 28.4 inches (72.136 cm).

Figure 10 shows computed principal polarization and cross-polarization radiation patterns taken at forty-five degrees where the maximum cross-polarization occurs, making an allowance for wind loading at 20 mph. From the patterns it can be seen that the gain of the antenna at zero degrees at center band, f = 3.95 GHz, is approximately 39 DB. Nulls between the main and side lobes occur substantially at two degree intervals as shown.

Thus, the Cassegrain antenna of the present invention is particularly adapted for mass production to provide a low cost antenna. While it is designed primarily as a TVRO antenna, and more particularly as a C-band antenna, certainly its unique design features offer significant advantages for other uses and at other frequency bands including Ku-band.

The main reflector, subreflector, and horn are all circularly symmetric. The antenna utilizes a near field design such that the near field focal point is deep within the horn, the near field focal point representing the phase and amplitude origin for shaping the main reflector and subreflector. Both the main reflector and subreflector are shaped in the sense that the main reflector is not a true parabola and the subreflector is not a true hyperbola. The antenna is "dual shaped" in that both the main reflector and subreflector are shaped in accordance with the horn pattern to optimize the energy distribution over the aperture of the main reflector for high efficiency. The corrugations and shaping of the horn provide substantially equal E and H plane feed patterns over a broad bandwidth at a low VSWR, and allows for a compact design placing the near field focal point, and hence the subreflector, closer to the main reflector. The near field design itself allows use of a much smaller subreflector placed substantially closer to the main reflector than is otherwise possible where the far field focal point is used. The horn configuration also has low cross-polarization, and a good spherical phase pattern down to a low energy level.

The invention utilizes a large F/D ratio, for example, .55, and preferably in excess of .5, to provide low cross-polarization and economy of labor and materials in making the main reflector. The shallower the main reflector, the less materials and supporting structures are required. The subreflector and main reflector are shaped to provide nulls in the radiation pattern at -4°, -2°, 2° and 4° to coincide with satellite spacing.

With the extender panels of the present invention, the effective aperture of the antenna can be increased. While it has been known to provide extender panels for a parabolic reflector, to do so created amplitude and phase error that moving the feed would not completely correct. With the dual shaped Cassegrain design of the present invention, the extender panels are also properly shaped, and any phase and amplitude distortion created by the addition of the panels is corrected merely by adjusting the location and shape of the subreflector. Thus, with the present invention the effective aperture of the antenna can be increased with the addition of the extender panels and a relatively simple and inexpensive replacement and adjustment of the subreflector.

Although the performance of the antenna can be optimized by changing the subreflector and moving it when the the extender panels are mounted to the main reflector, it is not necessarily required to change the subreflector to realize an increased performance. When the extender panels are added to increase the size of the main reflector dish, they effectively increase the noise shielding if the subreflector is not changed. This lowers the background noise, or T in a G/T gain-to-noise ratio, so that an improved performance is realized. As the gain portion of the antenna is only minimally improved, there is no substantial change in the null spacings of the main reflector antenna design. Thus, the extender panels may be utilized either with a different subreflector, or even without a different subreflector to improve the performance of the base antenna.

Thus, there has been described a Cassegrain antenna utilizing sophisticated design techniques to provide exceptional efficiency and which is particularly adapted for use as a TVRO antenna, and that can be mass produced at relatively low cost.

There are various changes and modifications which may be made to applicants' invention as would be apparent to those skilled in the art. However, any of these changes or modifications are included in the teaching of applicants' disclosure and they intend that their invention be limited only by the scope of the claims appended hereto.

APPENDIX A

X1 Inches	Y Inches
.00000	0.000000
.50000	0.001110077
1.0000	0.004449844
1.5000	0.01000977
2.0000	0.01778984
2.5000	0.02780914
3.0000	0.04004955
3.5000	0.05453968
4.0000	0.0712595
4.5000	0.09022999
5.0000	0.1114397
5.5000	0.1349201
6.0000	0.1606493
6.5000	0.1886501
7.0000	0.2189293
7.5000	0.2514801
8.0000	0.2863102
8.5000	0.3234291
9.0000	0.3628397
9.5000	0.4045401
10.000	0.4485502
10.500	0.4948492
11.000	0.5434494
11.500	0.5943489
12.000	0.6475496
12.500	0.7030497
13.000	0.76085
13.500	0.8208494
14.000	0.8832502

14.500	0.9478502
15.000	1.01475
15.500	1.08385
16.000	1.15525
16.500	1.228829
17.000	1.304669
17.500	1.38271
18.000	1.46295
18.500	1.545369
19.000	1.62995
19.500	1.716689
20.000	1.80556
20.500	1.89656
21.000	1.98966
21.500	2.08486
22.000	2.18213
22.500	2.281481
23.000	2.38289
23.500	2.486341
24.000	2.591828
24.500	2.699359
25.000	2.808909
25.500	2.920489
26.000	3.034081
26.500	3.1497
27.000	3.26733
27.500	3.38698
28.000	3.50866
28.500	3.63238
29.000	3.75812
29.500	3.885919
30.000	4.015759
30.500	4.14768
31.000	4.28166
31.500	4.41773

32.000	4.55589
32.500	4.696159
33.000	4.83854
33.500	4.98303
34.000	5.12966
34.500	5.27842
35.000	5.42931
35.500	5.58234
36.000	5.73749
36.500	5.894769
37.000	6.05417
37.500	6.21566
38.000	6.37923
38.500	6.544859
39.000	6.71252
39.500	6.882179
40.000	7.0538
40.500	7.22734
41.000	7.40276
41.500	7.58
42.000	7.75901
42.500	7.93973
43.000	8.12211
43.500	8.306069
44.000	8.49156
44.500	8.6785
45.000	8.86684
45.500	9.0565
46.000	9.247419
46.500	9.439529
47.000	9.63278
47.500	9.82712
48.000	10.0225
48.500	10.21887
49.000	10.41621

49.500	10.61448
50.000	10.81368
50.500	11.01379
51.000	11.21484
51.500	11.41683
52.000	11.6198
52.500	11.8238
53.000	12.02887
53.500	12.23509
54.000	12.44253
54.500	12.65129
55.000	12.86145
55.500	13.07313
56.000	13.28642
56.500	13.50143
57.000	13.71828
57.500	13.93707
58.000	14.15788
58.500	14.38082
59.000	14.60594
59.500	14.8333
60.000	15.06294
60.500	15.29485
61.000	15.52902
61.500	15.76541
62.000	16.00394
62.500	16.24451
63.000	16.48701
63.500	16.73129
64.000	16.97723
64.500	17.2247
65.000	17.47358
65.500	17.72384
66.000	17.97551
66.500	18.22874

67.000	18.48388
67.500	18.74147
68.000	19.00239
68.500	19.26789
69.000	19.53971

APPENDIX B

43" Radius Optical Edge		44" Radius Optical Edge	
X2 (Inches)	Y (Inches)	X2 (Inches)	Y (Inches)
.00000	.00000	.00000	.00000
.25000	.02582	.25000	.02572
.50000	.05138	.50000	.05116
.75000	.07718	.75000	.07709
1.00000	.10415	1.00000	.10415
1.25000	.13250	1.25000	.13275
1.50000	.16285	1.50000	.16345
1.75000	.19506	1.75000	.19623
2.00000	.22960	2.00000	.23137
2.25000	.26623	2.25000	.26874
2.50000	.30511	2.50000	.30834
2.75000	.34610	2.75000	.35036
3.00000	.38926	3.00000	.39447
3.25000	.43439	3.25000	.44068
3.50000	.48152	3.50000	.48886
3.75000	.53022	3.75000	.53879
4.00000	.58047	4.00000	.59025
4.25000	.63202	4.25000	.64345
4.50000	.68499	4.50000	.69797
4.75000	.73917	4.75000	.75352
5.00000	.79409	5.00000	.80990
5.25000	.84999	5.25000	.86743
5.50000	.90660	5.50000	.92574
5.75000	.96358	5.75000	.98429
6.00000	1.02105	6.00000	1.04336
6.25000	1.07881	6.25000	1.10305
6.50000	1.13673	6.50000	1.16271
6.75000	1.19463	6.75000	1.22232

7.00000	1.25265	7.00000	1.28192
7.25000	1.31024	7.25000	1.34154
7.50000	1.36771	7.50000	1.40086
7.75000	1.42465	7.75000	1.45974
8.00000	1.48144	8.00000	1.51841
8.25000	1.53757	8.25000	1.57661
8.50000	1.59329	8.50000	1.63403
8.75000	1.64826	8.75000	1.69100
9.00000	1.70259	9.00000	1.74738
9.25000	1.75645	9.25000	1.80307
9.50000	1.80929	9.50000	1.85785
9.75000	1.86152	9.75000	1.91206
10.00000	1.91288	10.00000	1.96549
10.25000	1.96340	10.25000	2.01811
10.50000	2.01319	10.50000	2.06972
10.75000	2.06203	10.75000	2.12058
11.00000	2.10982	11.00000	2.17052

APPENDIX C

Y	Inside Radius (Inches)	Y	Outside Radius (Inches)
0.0	6.000	-0.7803	6.750
-0.8	6.000	-1.5803	6.750
-1.6	6.000	-2.3803	6.750
-2.4	6.000	-3.1803	6.750
-3.2	6.000	-3.9795	6.724
-4.0	5.943	-4.7793	6.657
-4.8	5.867	-5.5790	6.572
-5.6	5.773	-6.3788	6.469
-5.6	5.661	-7.1786	6.349
-7.2	5.533	-7.9784	6.213
-8.0	5.389	-8.7782	6.061
-8.8	5.229	-9.5780	5.895
-9.6	5.056	-10.3778	5.715
-10.4	4.871	-11.1777	5.524
-11.2	4.675	-11.9776	5.323
-12.0	4.469	-12.775	5.114
-12.8	4.256	-13.5774	4.898
-13.6	4.038	-14.3774	4.677
-14.4	3.815	-15.1773	4.453
-15.2	3.590	-15.9774	4.228
-16.0	3.366	-16.7774	4.004
-16.8	3.143	-17.5775	4.783
-17.6	2.925	-18.3775	3.567
-18.4	2.712	-19.1776	3.358
-19.2	2.506	-19.9777	3.157
-20.0	2.310	-20.7779	2.966

-20.8	2.125
-21.6	1.952
-22.4	1.792
-23.2	1.648
-24.0	1.520
-24.8	1.408
-25.6	1.314
-26.4	1.238

-21.5773	2.816
-22.3767	2.680
-23.1761	2.591
-23.9732	2.538
-24.7700	2.514
-25.5681	2.599
-26.3582	2.768

What Is Claimed Is:

1.

An antenna of the Cassegrain type comprising a main reflector, subreflector, and horn, the horn in the near field of the subreflector with the near field focal point deep within the horn, said main reflector having a superstructure with an electromagnetic energy reflective covering on a reflective side thereof, said horn extending from said superstructure with the mouth thereof facing the reflective side of said subreflector, said subreflector mounted at the outer ends of spars extending from said main reflector, the reflective surface of said subreflector and inner surface of said horn being of an electromagnetic energy reflective and conductive material, said horn, superstructure, and subreflector each being characterized by being formed of plastic molded construction.

2.

The antenna of Claim 1 wherein said horn has radial, integrally molded, plastic webs extending toward said spars.

3.

The antenna of Claim 1 wherein said main reflector, subreflector, and horn are circularly symmetric.

4.

The antenna of Claim 1 wherein said horn is a corrugated, profiled horn.

5.

The antenna of Claim 4 wherein the wall of said horn in longitudinal cross section is generally S-shaped.

6.

The antenna of Claim 5 wherein the corrugations of said horn extend generally the full length thereof.

7.

The antenna of Claim 1 wherein said superstructure is of a honeycomb configuration.

8.

The antenna of Claim 1 wherein said superstructure further comprises a central panel and multiple outer petals joined to said central panel, each petal joined to a petal at each side thereof, the central panel and petals each being of molded plastic construction and being shaped such that assembled, with the covering on the reflective side thereof, there is provided a smoothly shaped main reflector.

9.

The antenna of Claim 8 wherein the central panel and petals are each double curved.

10.

The antenna of Claim 1 wherein said covering is a mesh.

11.

The antenna of Claim 10 wherein said mesh is formed of die-cut aluminum.

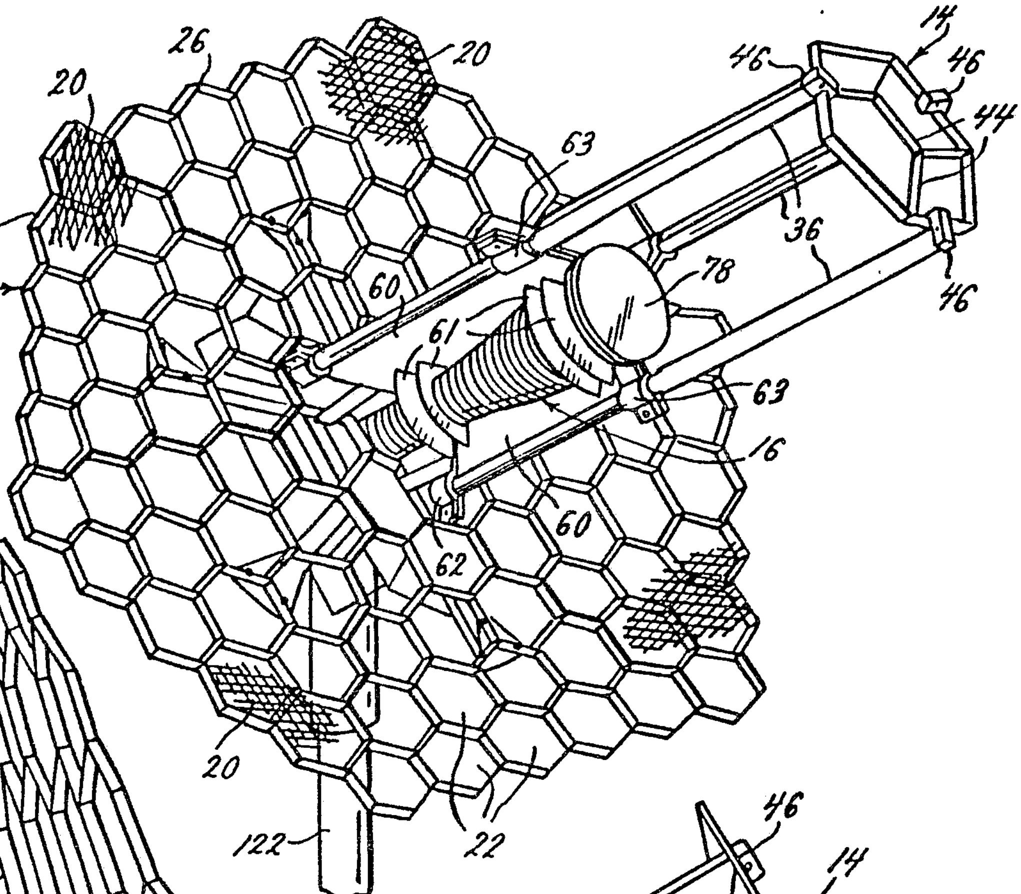
12.

The antenna of Claim 1 wherein the reflective surface of said subreflector and inner surface of said horn have a first coating of copper and an outer coating of nickel.

13.

The antenna of Claim 1 wherein said horn has corrugated straight portions at the throat and mouth ends thereof with a corrugated intermediate portion therebetween, the straight portion at the mouth of the horn being of larger diameter than that at the throat of the horn, the transitions between said throat, intermediate, and mouth portions being smooth such that the shape of the horn wall in longitudinal cross section through all portions is generally S-shaped.

FIG. 1.


26
20
14
46
46
44
63
18
36
78
12
60
61
46
10
63
16
60
62
20
22
122

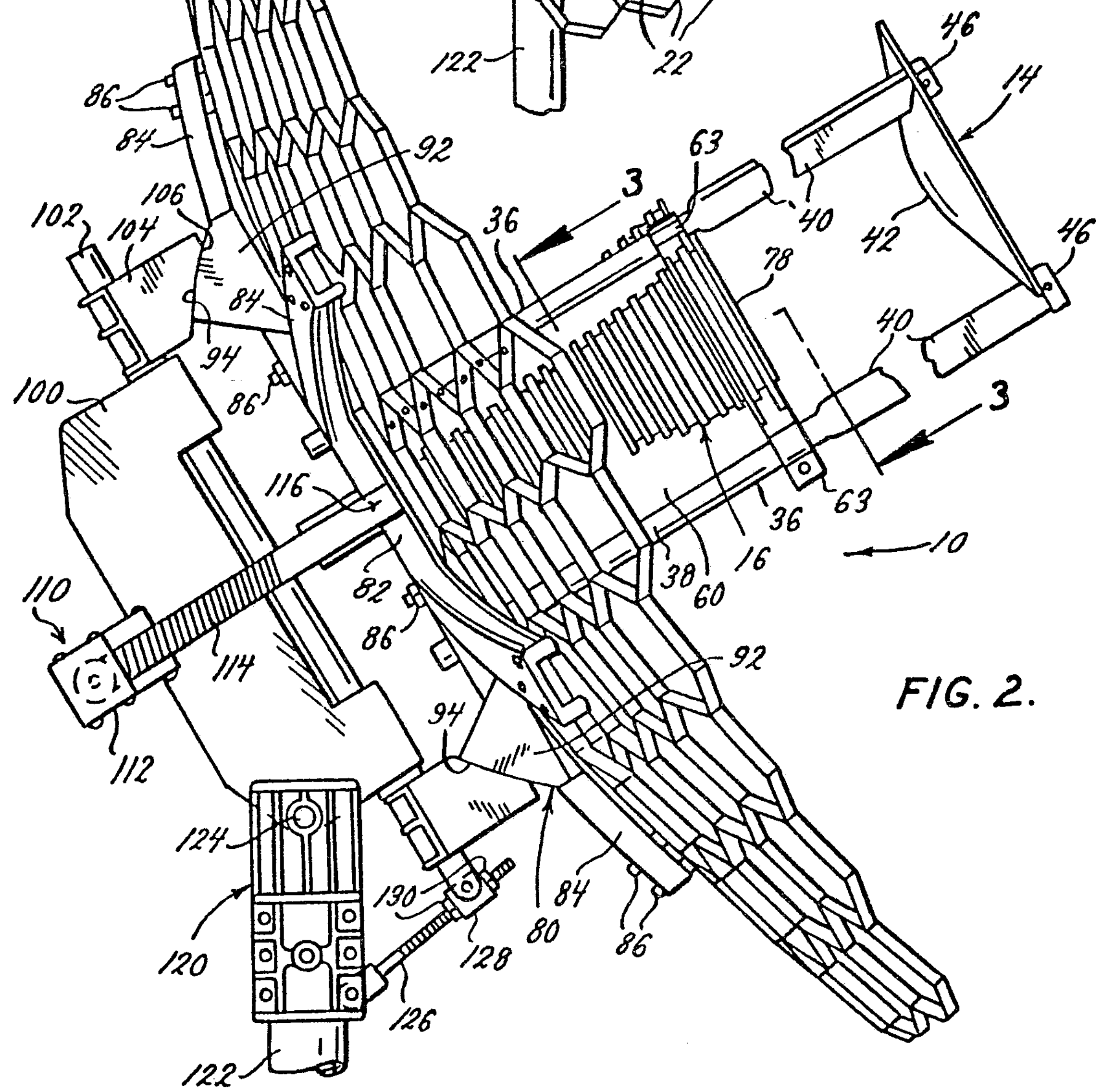
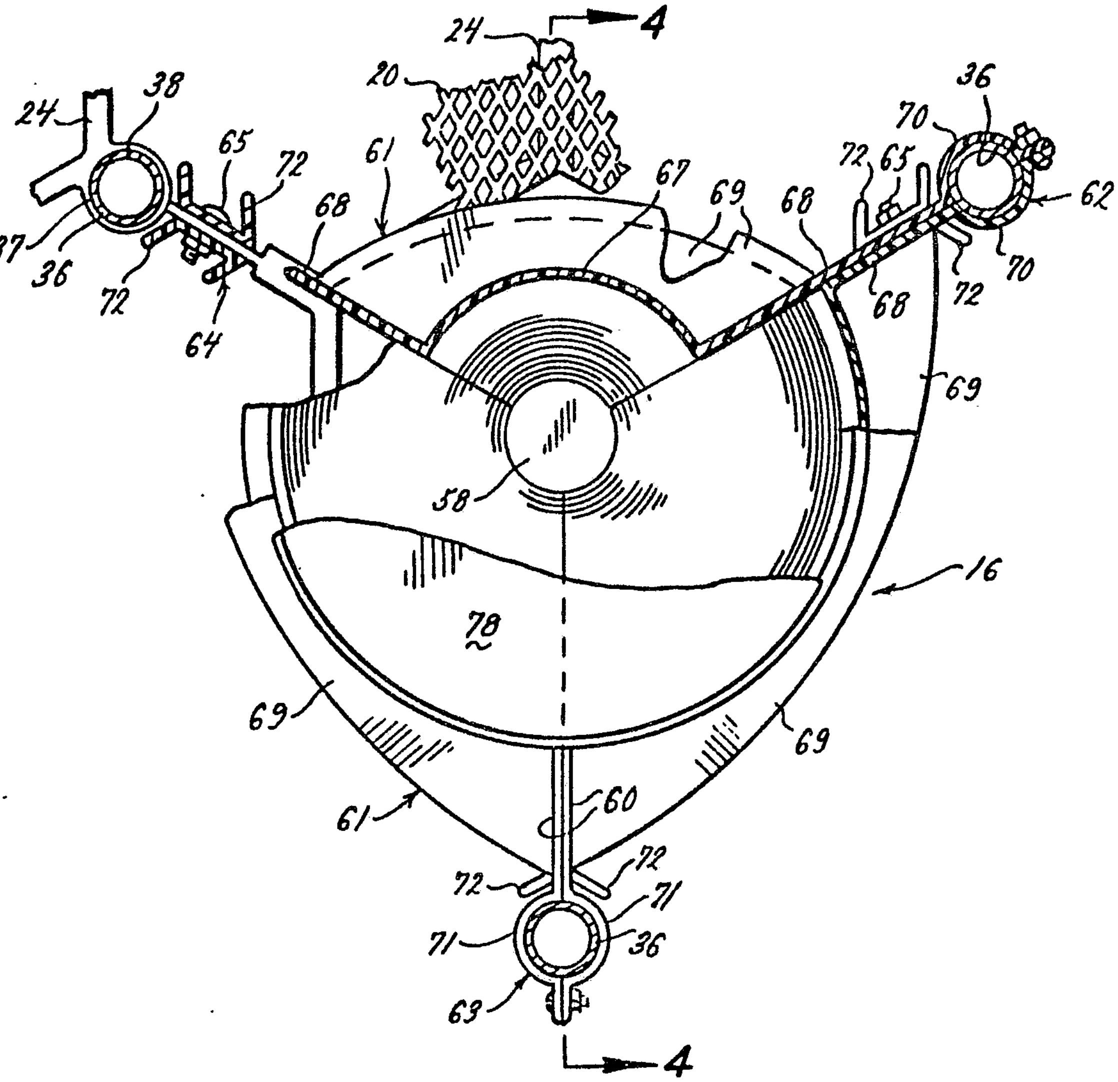

12
18
86
84
102
104
106
92
36
63
3
40
46
14
42
46
84
94
78
40
100
86
116
63
36
16
38
60
10
82
110
114
86
92
112
94
124
120
130
128
80
84
86
126
122

FIG. 2.

FIG. 3.


4
24
20
24
38
65
72
61
67
69
68
36
70
72
65
62
37
36
72
64
68
68
72
70
69
58
16
78
69
69
61
60
72
72
71
71
36
63
4

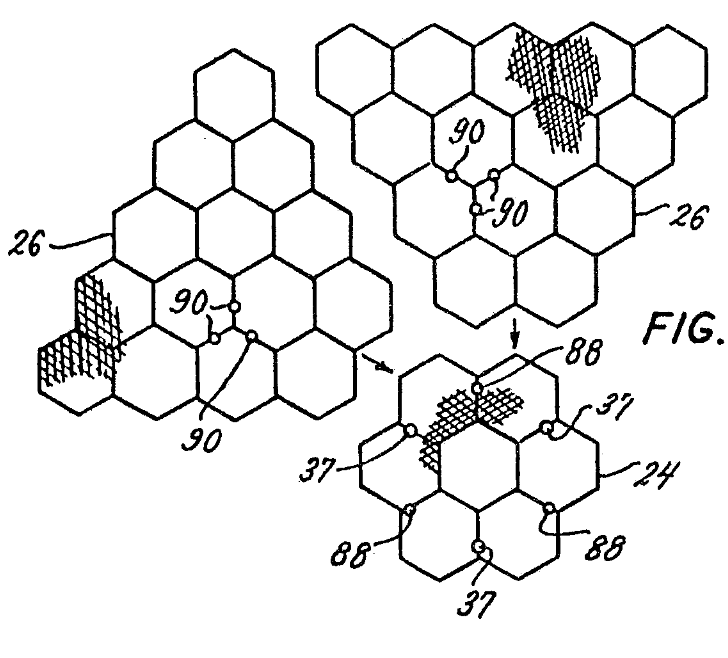

90
90
26
26
90
90
88
37
37
24
88
88
37

FIG. 7.

0196734

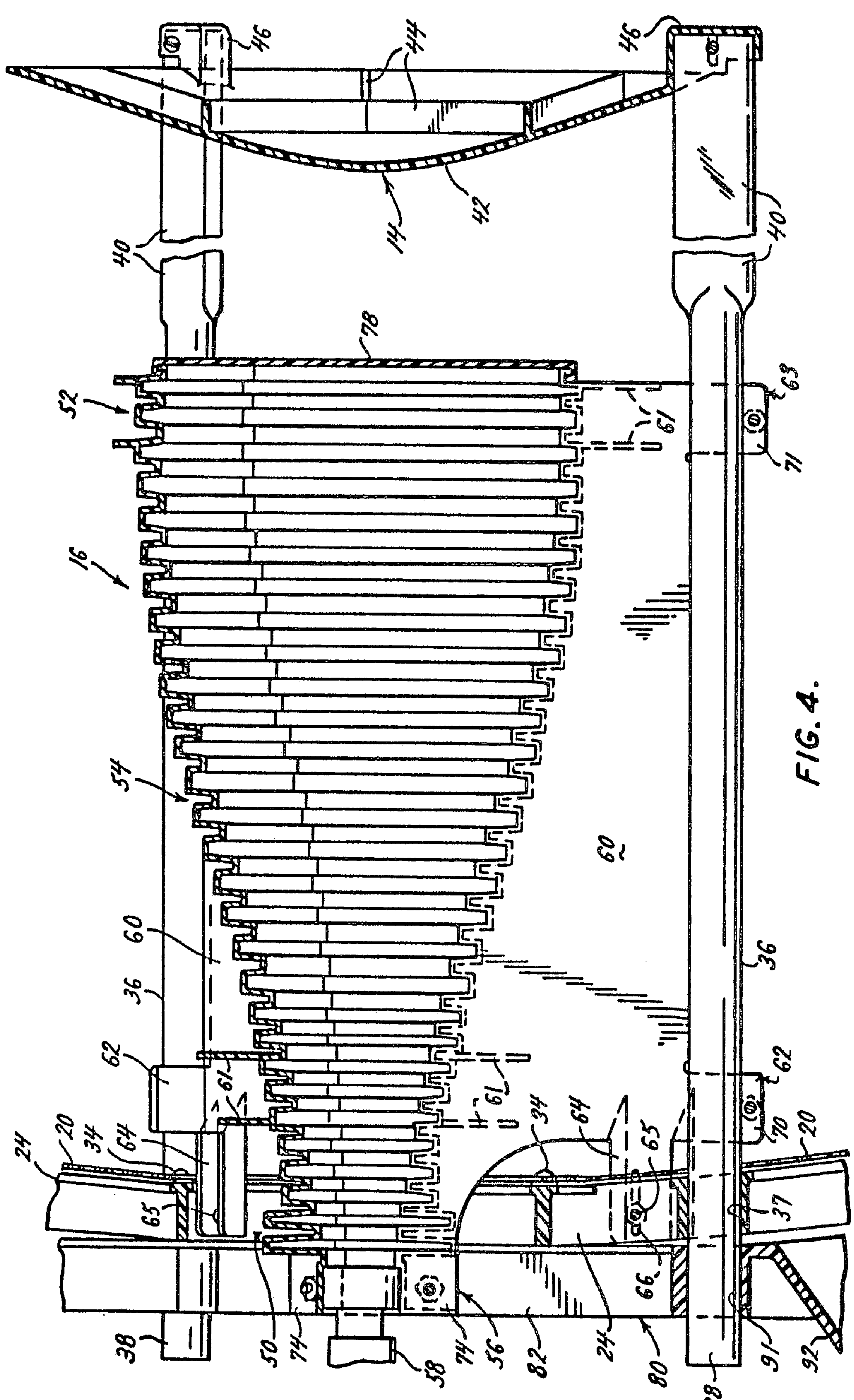
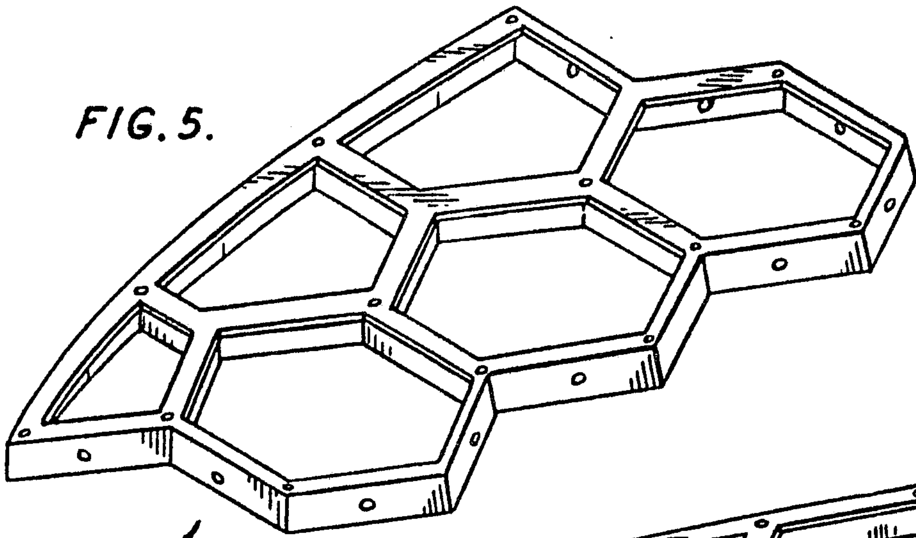


FIG. 4.

FIG. 5.



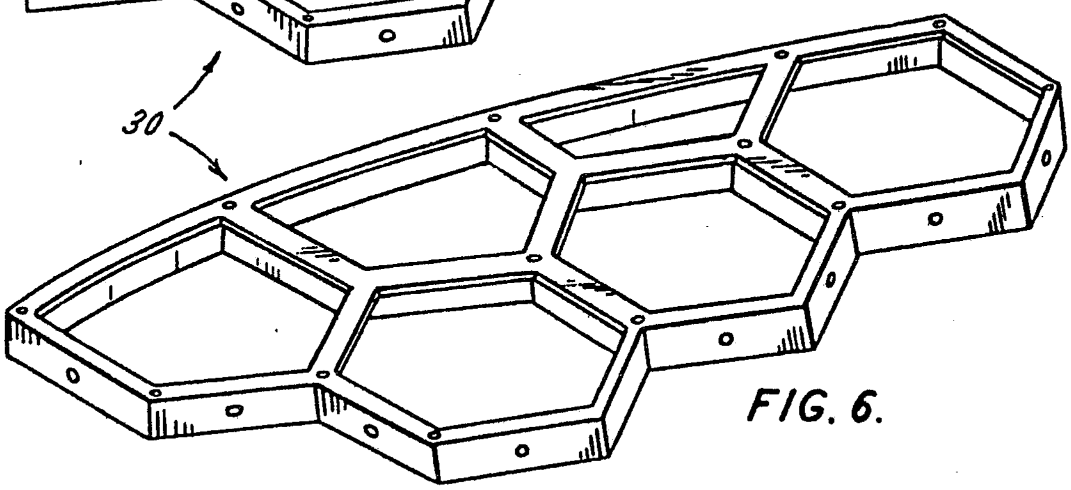


FIG. 6.

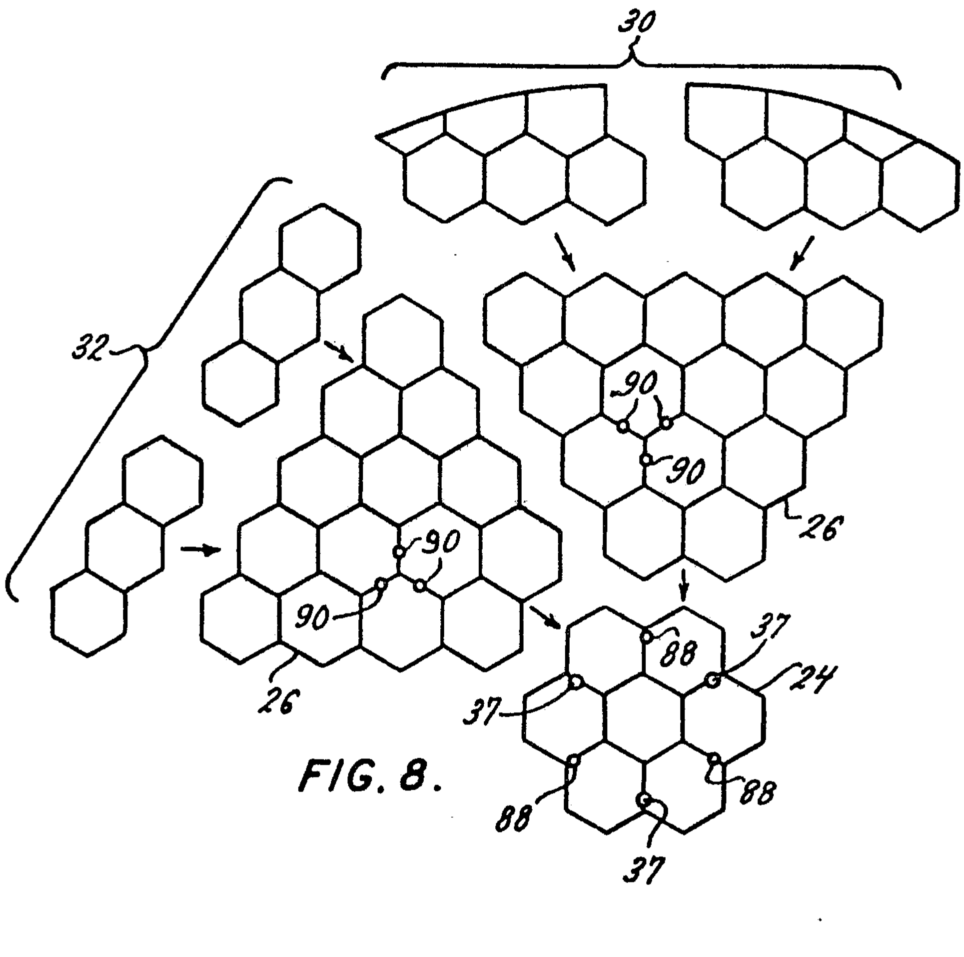
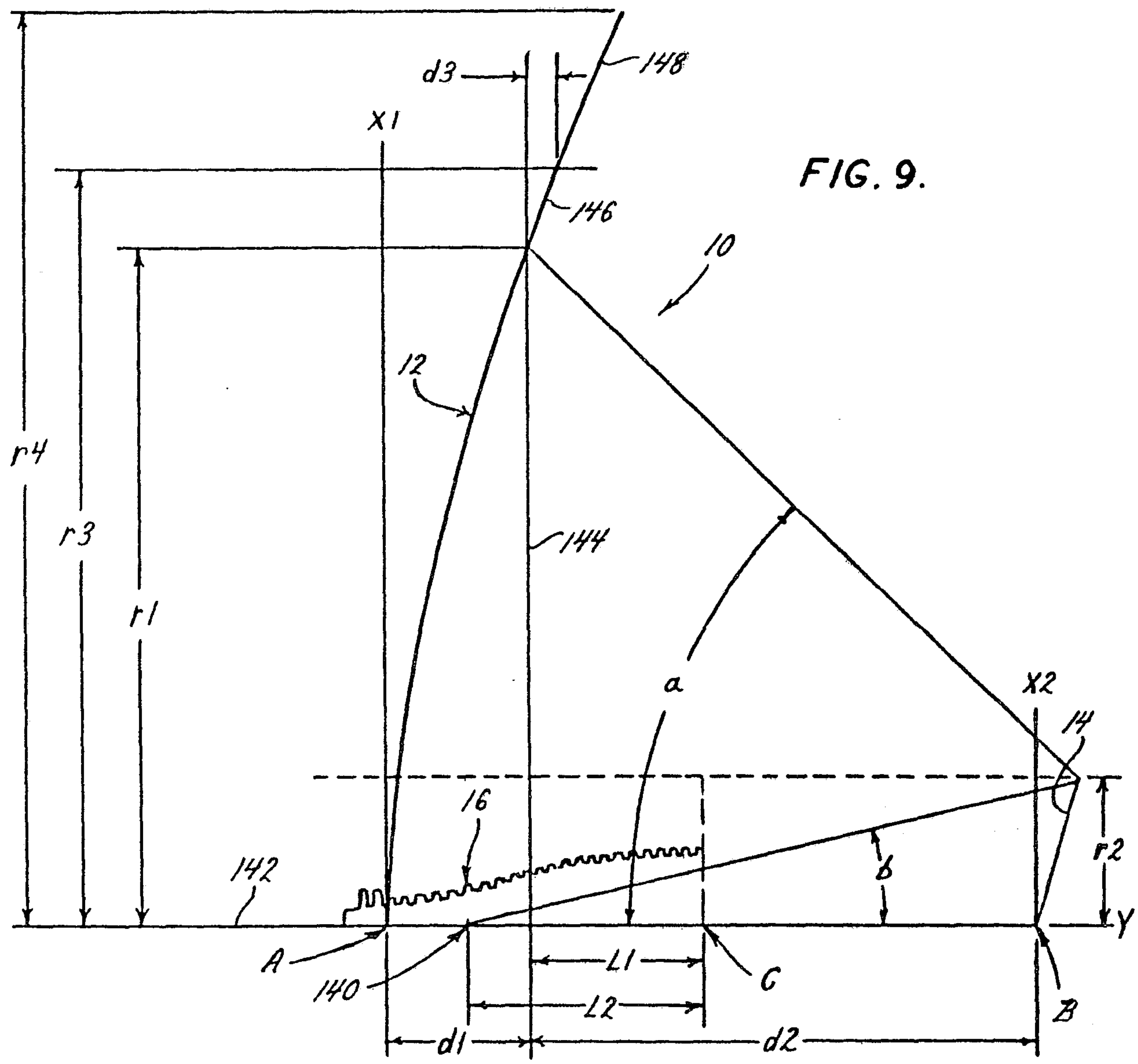
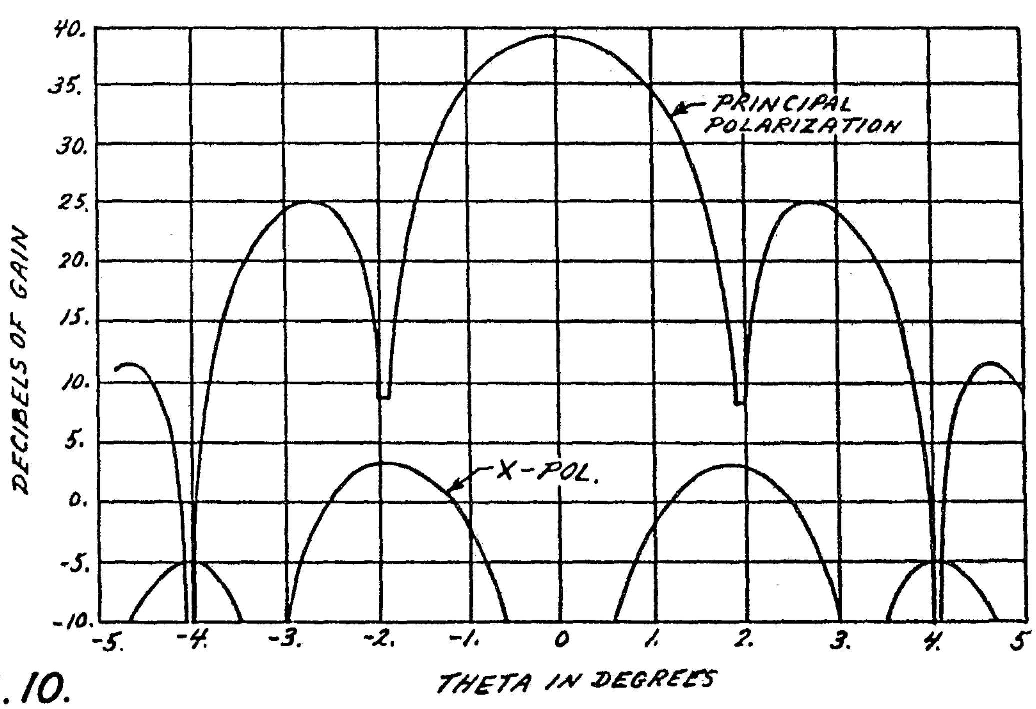


FIG. 8.



d3
148
X1
146
10
12
r4
r3
r1
144
a
X2
14
16
142
r2
b
Y
A
140
L1
C
L2
B
d1
d2

FIG. 9.



40.
35.
30.
25.
20.
15.
10.
5.
0.
-5.
-10.
DECIBELS OF GAIN
PRINCIPAL POLARIZATION
X-POL.
-5.
-4.
-3.
-2.
-1.
0
1.
2.
3.
4.
5
THETA IN DEGREES

FIG. 10.