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Gierow et al.

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(54) **INFLATABLE ANTENNA**

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(51) **Int. Cl.**[7] **H01Q 15/20**
(52) **U.S. Cl.** **343/872**; 343/881; 343/915
(58) **Field of Search** 343/912, 915, 343/880, 872, 881, 840; 342/8, 10

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,587,098 A 6/1971 Gosnell
3,715,759 A 2/1973 Esposito et al.
3,957,228 A 5/1976 Kennedy, Jr.
4,482,333 A 11/1984 Geri et al.
4,673,934 A 6/1987 Gentry et al.
4,768,739 A 9/1988 Schnee
4,901,081 A 2/1990 Bain, Jr. et al.
4,980,688 A 12/1990 Dozier, Jr.
4,996,536 A 2/1991 Broadhurst
5,017,925 A 5/1991 Bertiger et al.
5,132,699 A * 7/1992 Rupp et al. 343/880
5,166,696 A * 11/1992 Rupp et al. 343/711
5,386,953 A 2/1995 Stuart
5,597,335 A 1/1997 Woodland
5,641,135 A 6/1997 Stuart et al.
5,986,619 A 11/1999 Grybos et al.
6,115,003 A 9/2000 Kozakoff
6,167,924 B1 1/2001 Buckley et al.
6,168,116 B1 1/2001 Renshall et al.
6,300,893 B1 10/2001 Schaff et al.
6,650,304 B2 * 11/2003 Lee et al. 343/915

FOREIGN PATENT DOCUMENTS

WO WO 00/57685 A3 10/2000

OTHER PUBLICATIONS

SPACENEWS, Army Awards $24 Million Satellite Terminals Contract to L3 Apr. 21, 2003, p. 13.
Stuart Luman, Air Ball Wired Apr. 2003. 051.

* cited by examiner

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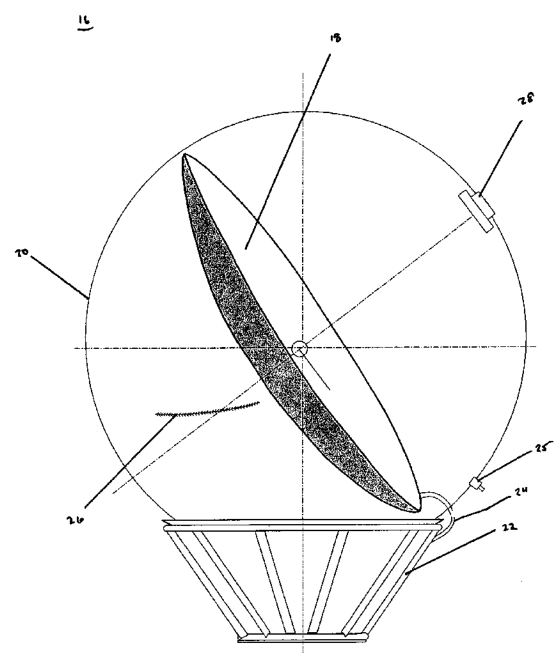
(57) **ABSTRACT**

The invention is an inflatable antenna system. The antenna system includes an inflatable lenticular dish. The dish is enclosed in an inflatable radome. The inflatable radome stabilizes the orientation of the dish and protects it from environment conditions such as wind.

18 Claims, 18 Drawing Sheets



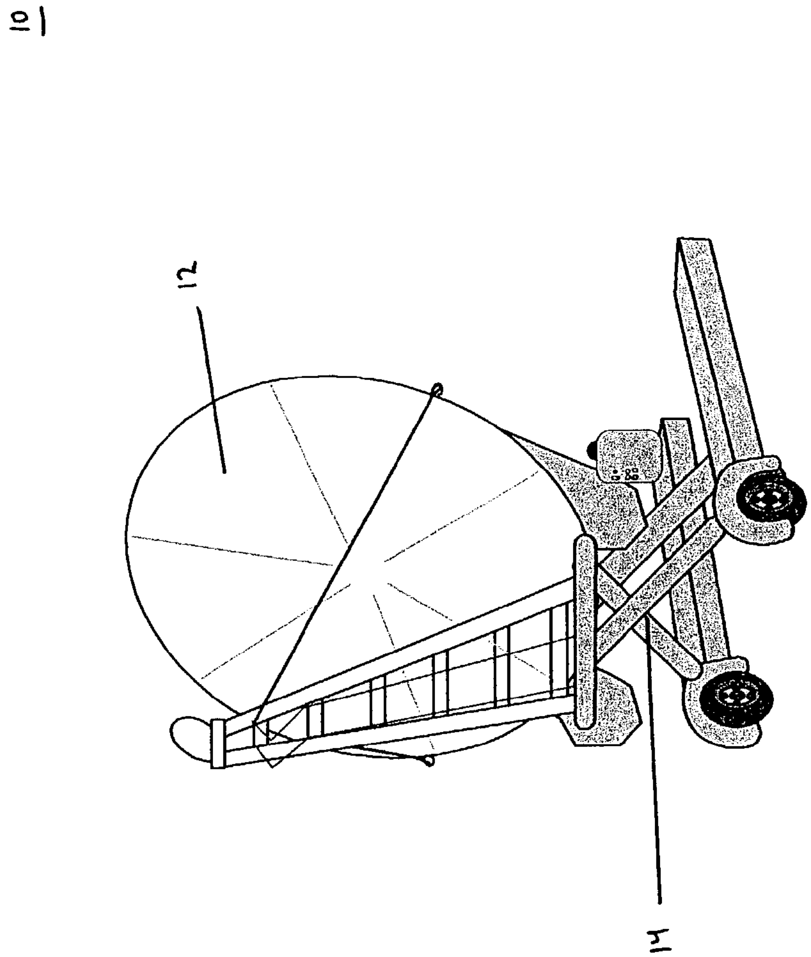


Figure 1
Prior Art

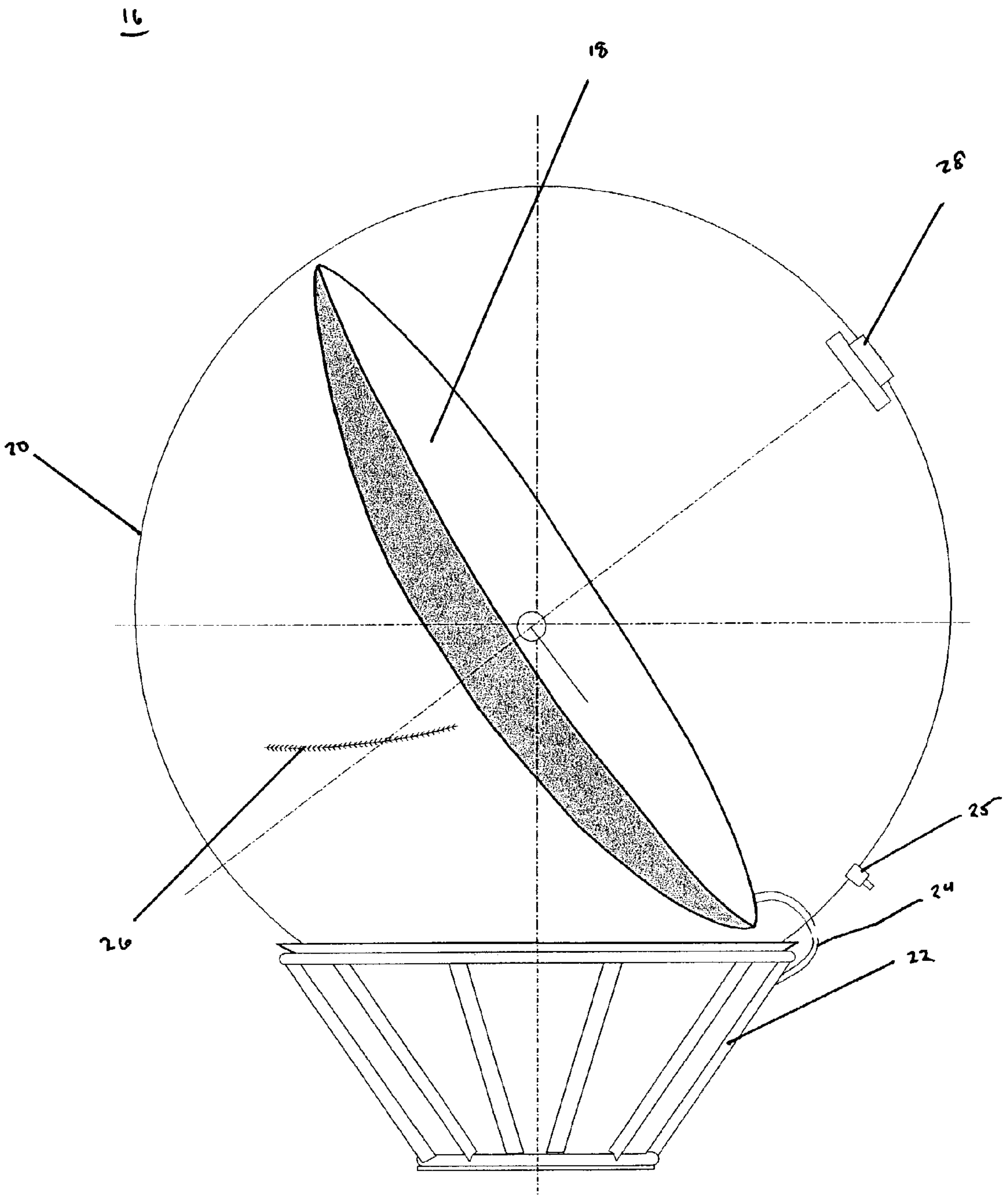


Figure 2a

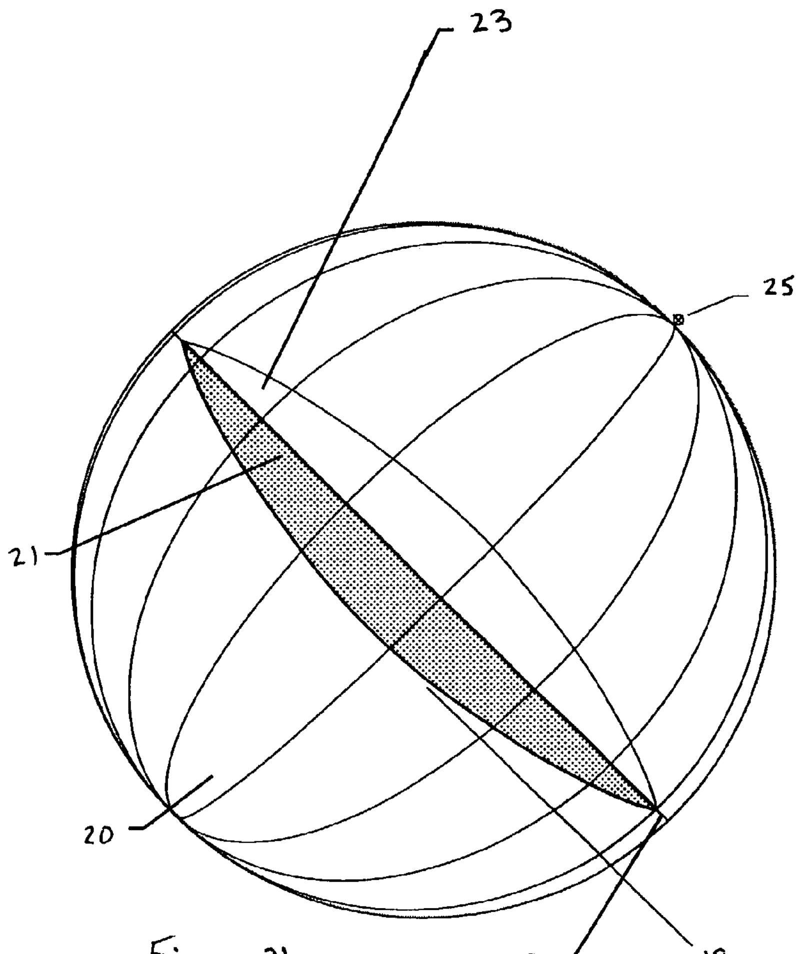


Figure 2b

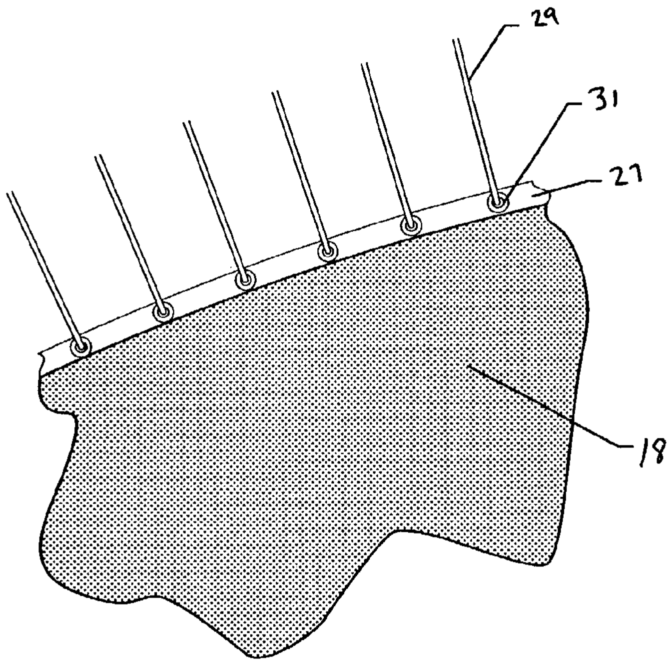


Figure 2c

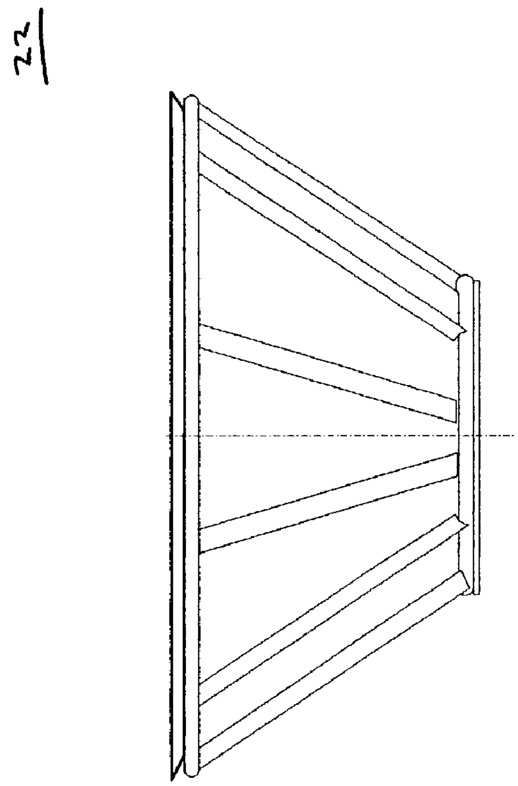


Figure 3b

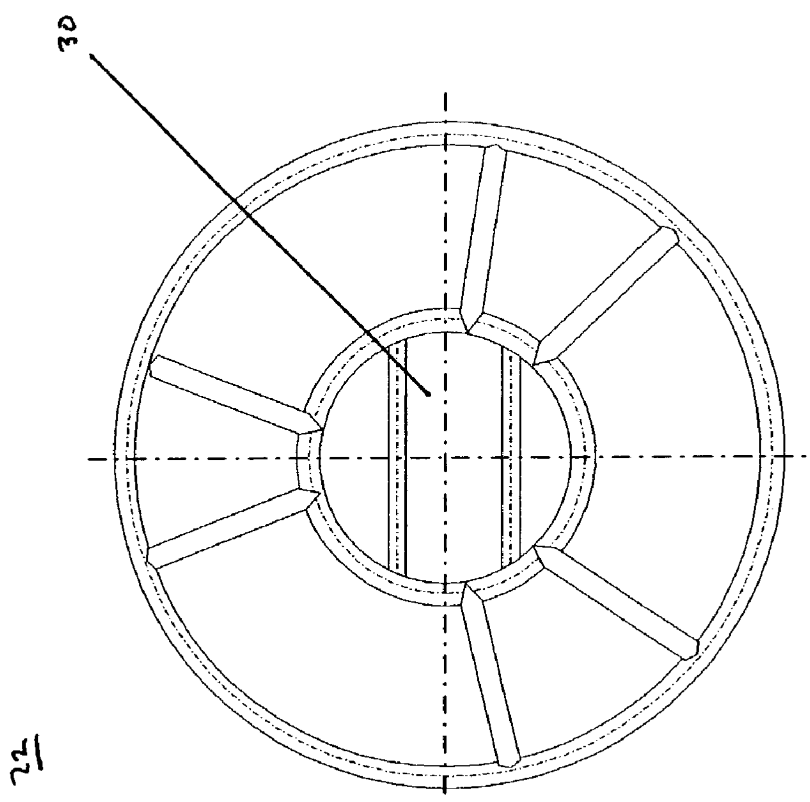


Figure 3a

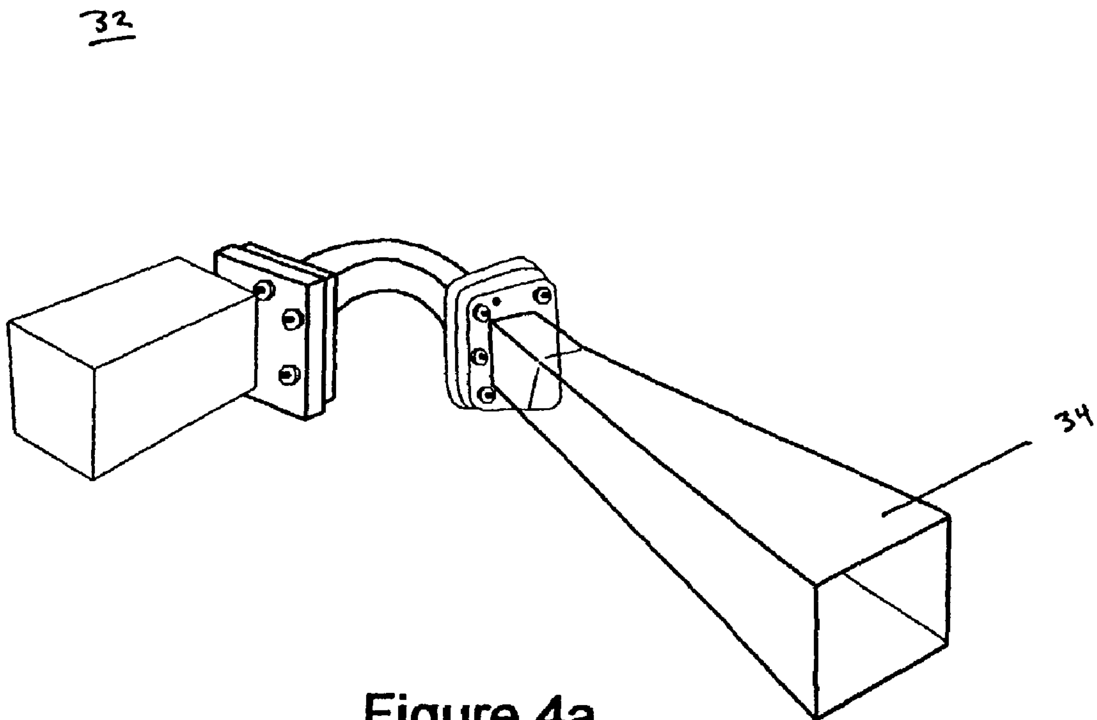


Figure 4a

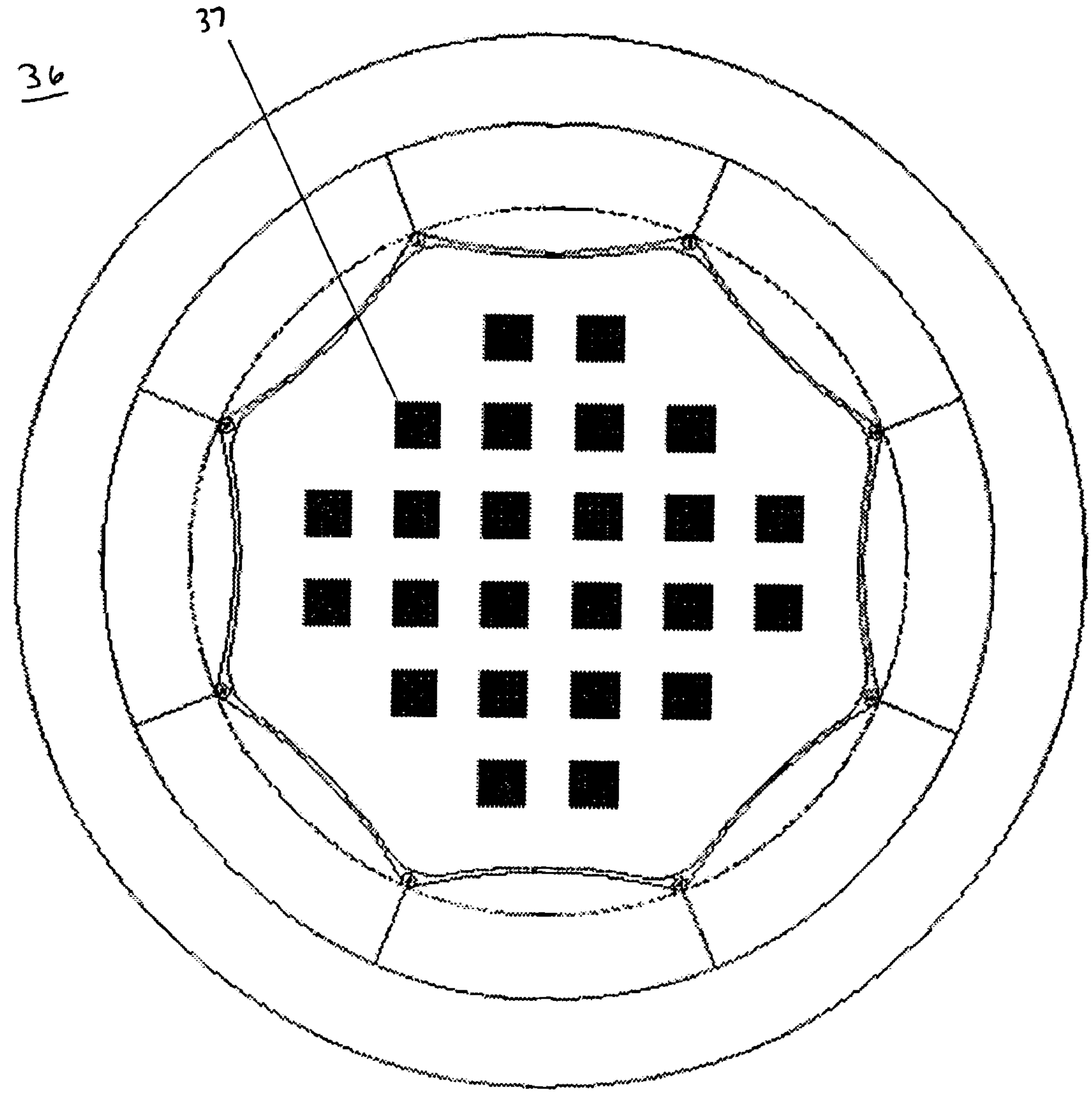


Figure 4b

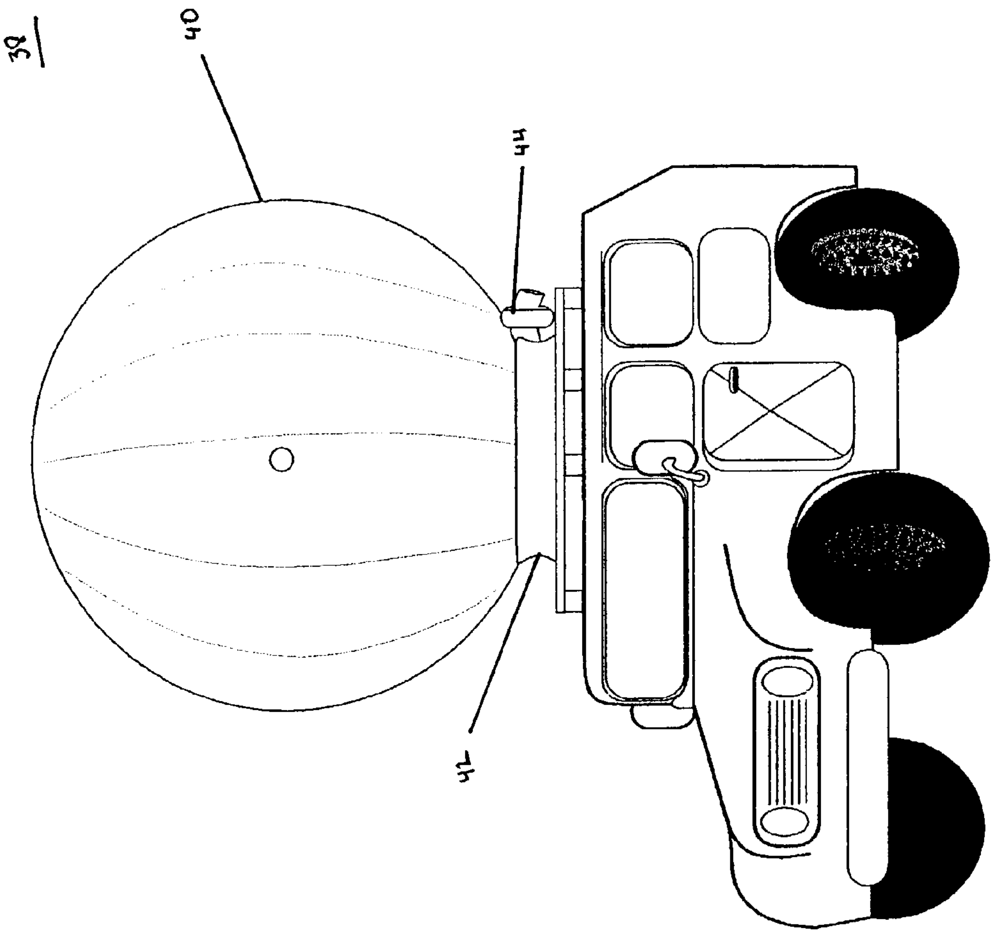


Figure 5

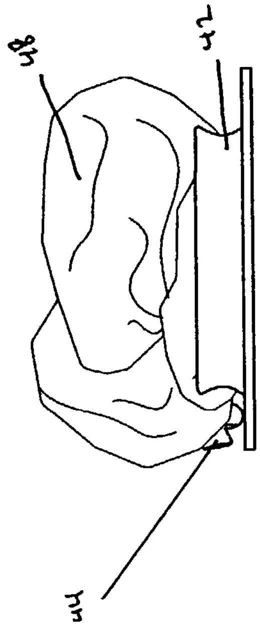


Figure 6c

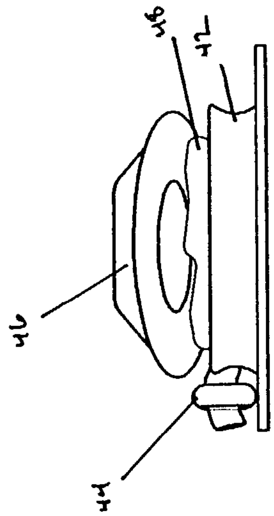
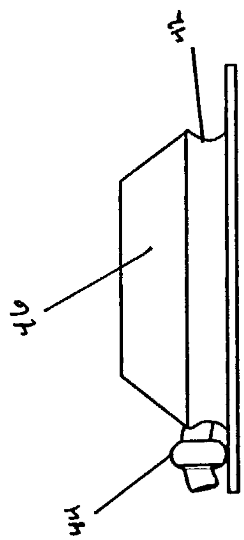


Figure 6b



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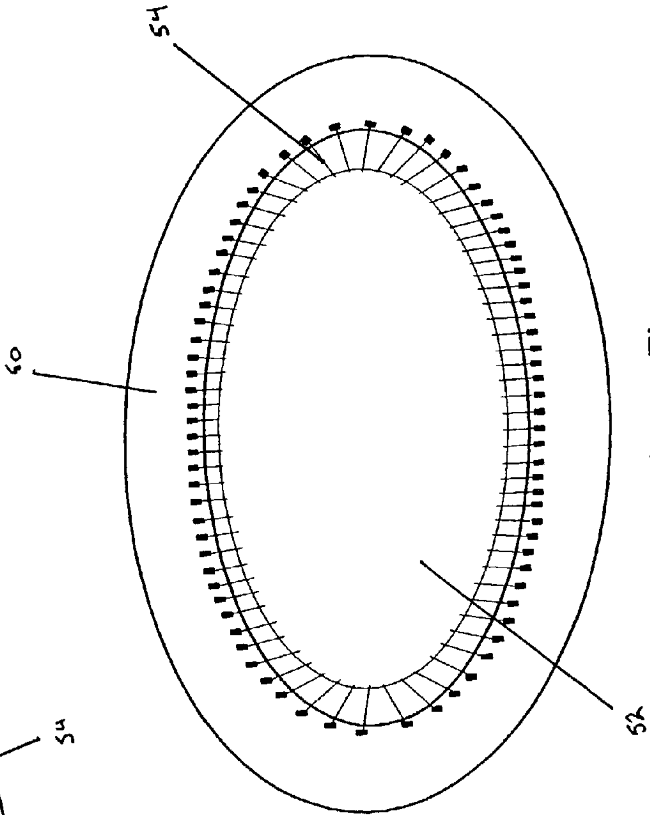


Figure 7b

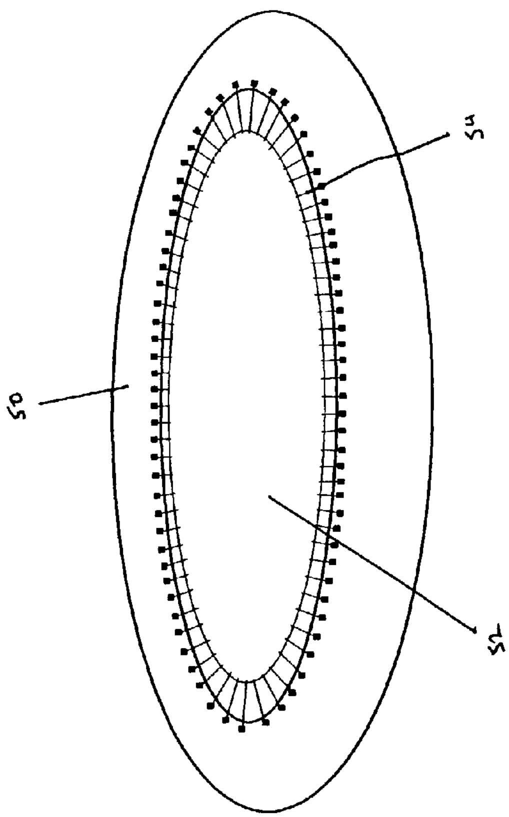
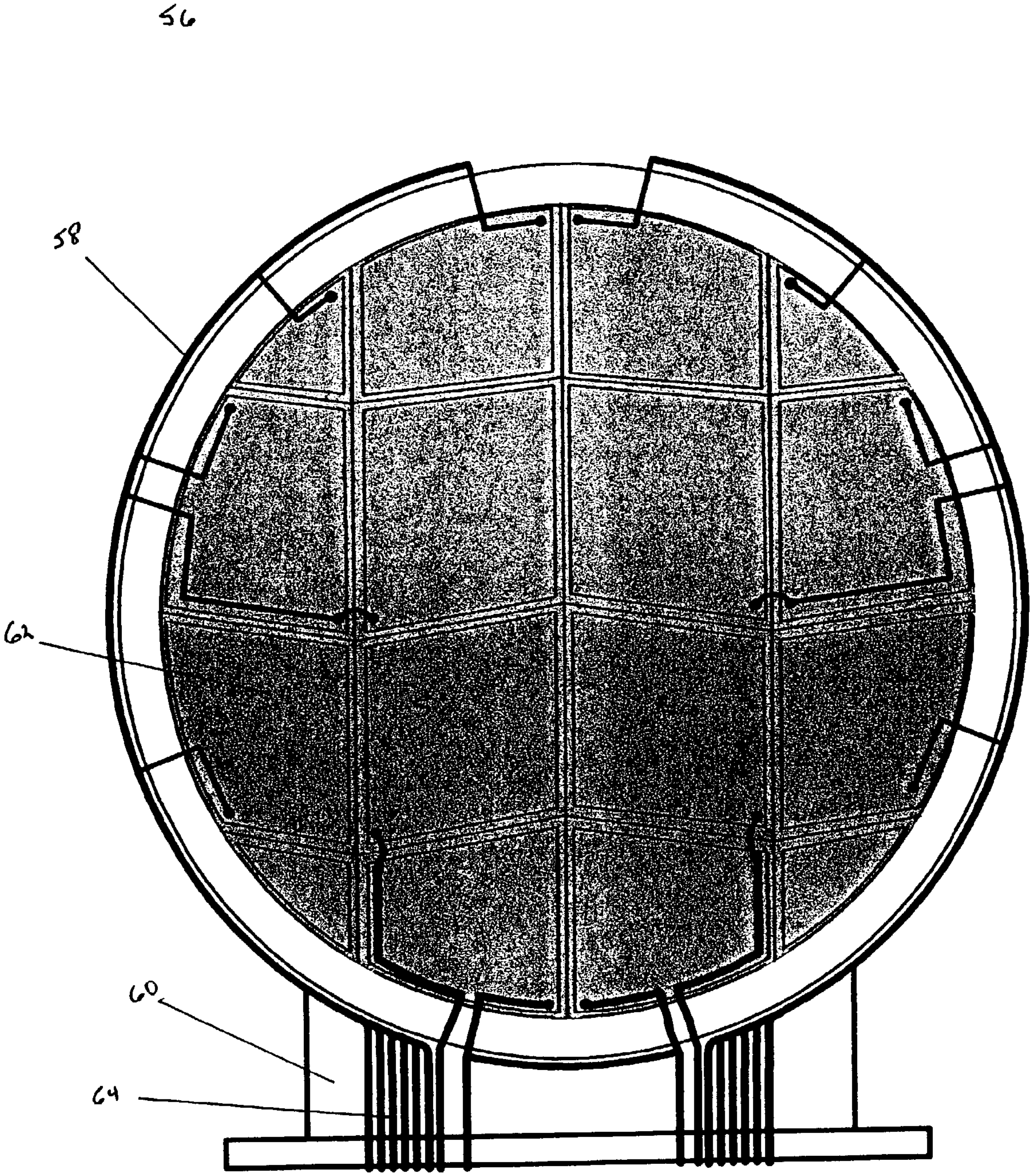


Figure 7a



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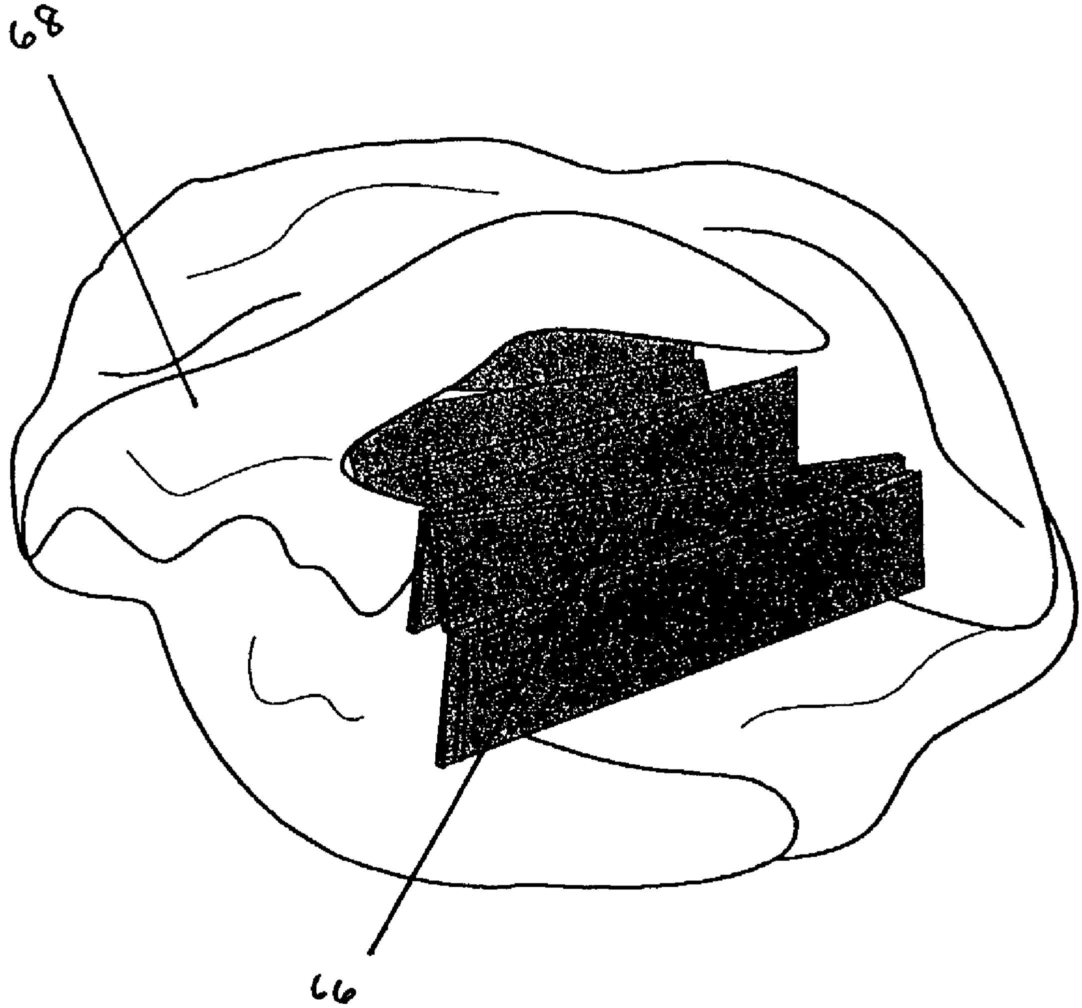

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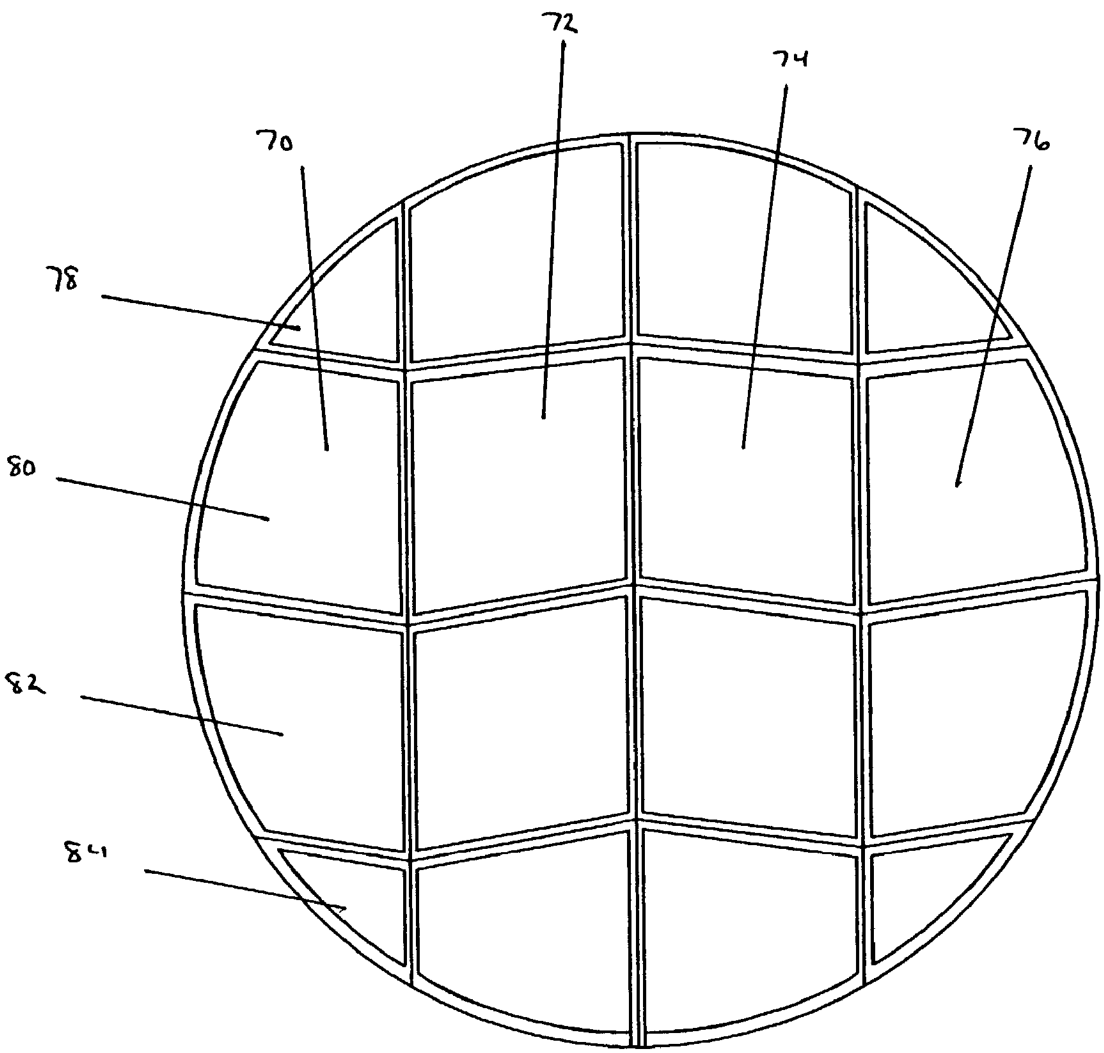

Figure 10

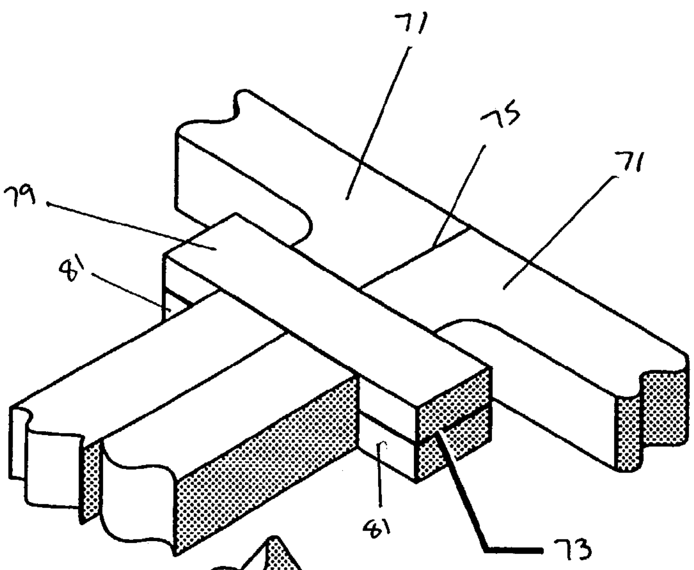

Figure 11

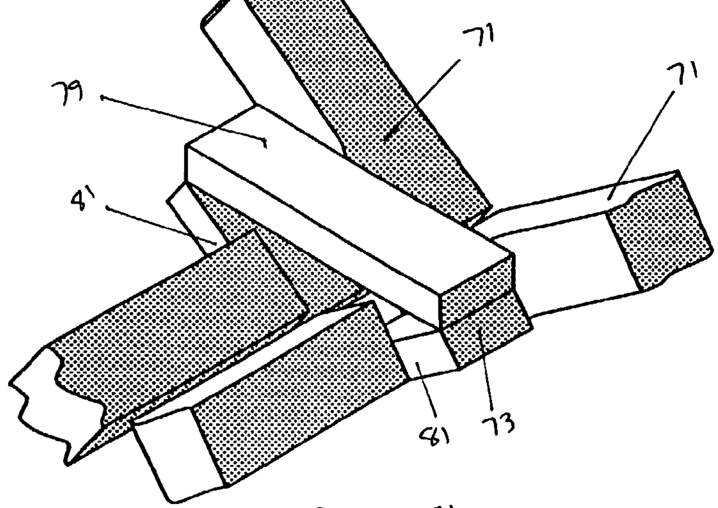

Figure 12a

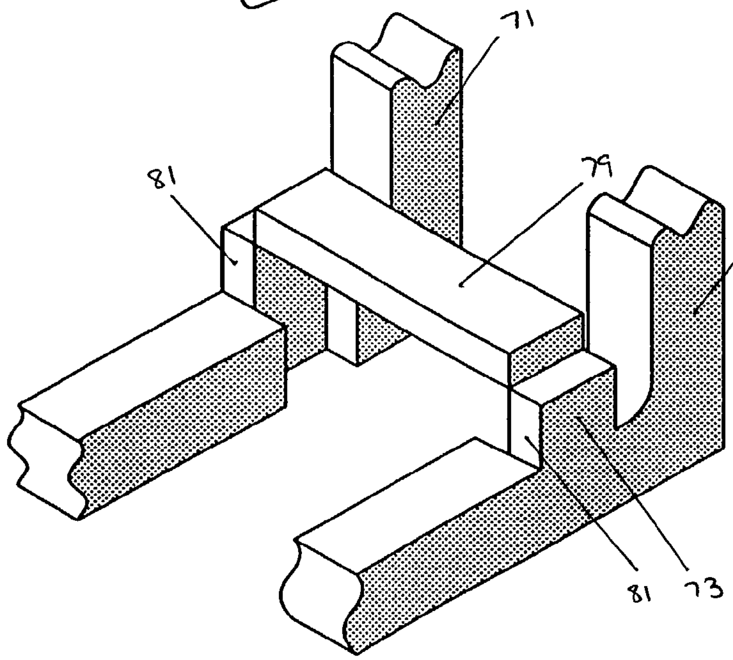

Figure 12b

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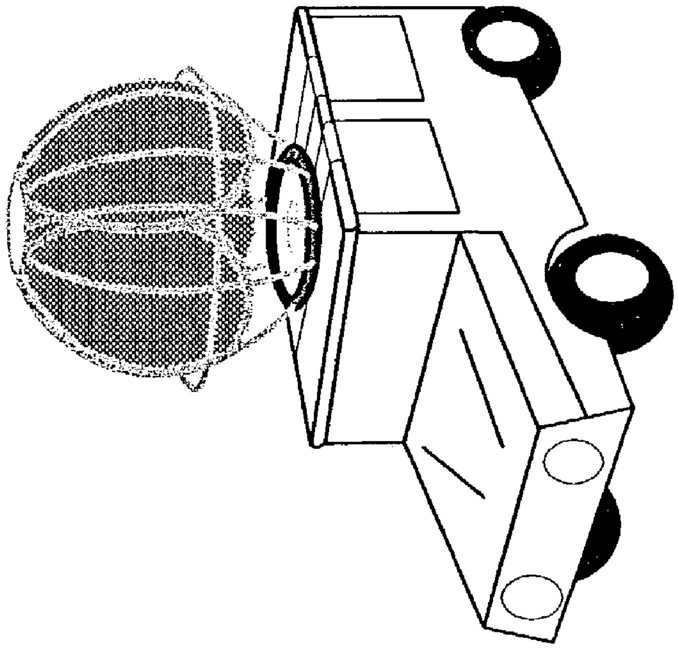

Figure 13b

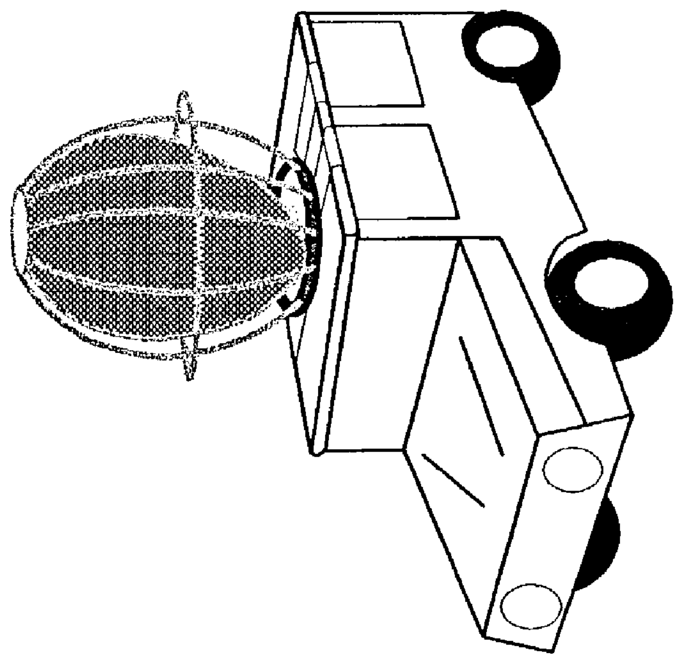

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Figure 13a

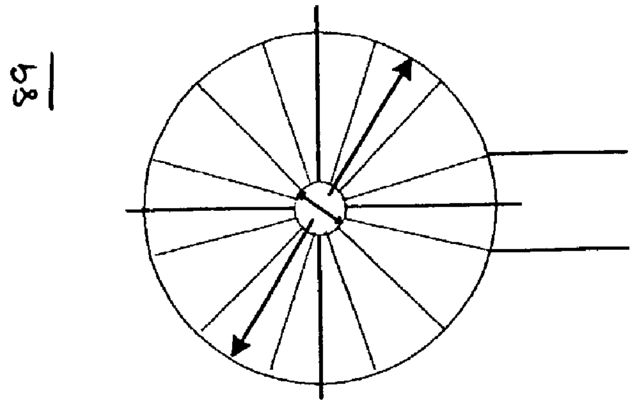

Figure 14b

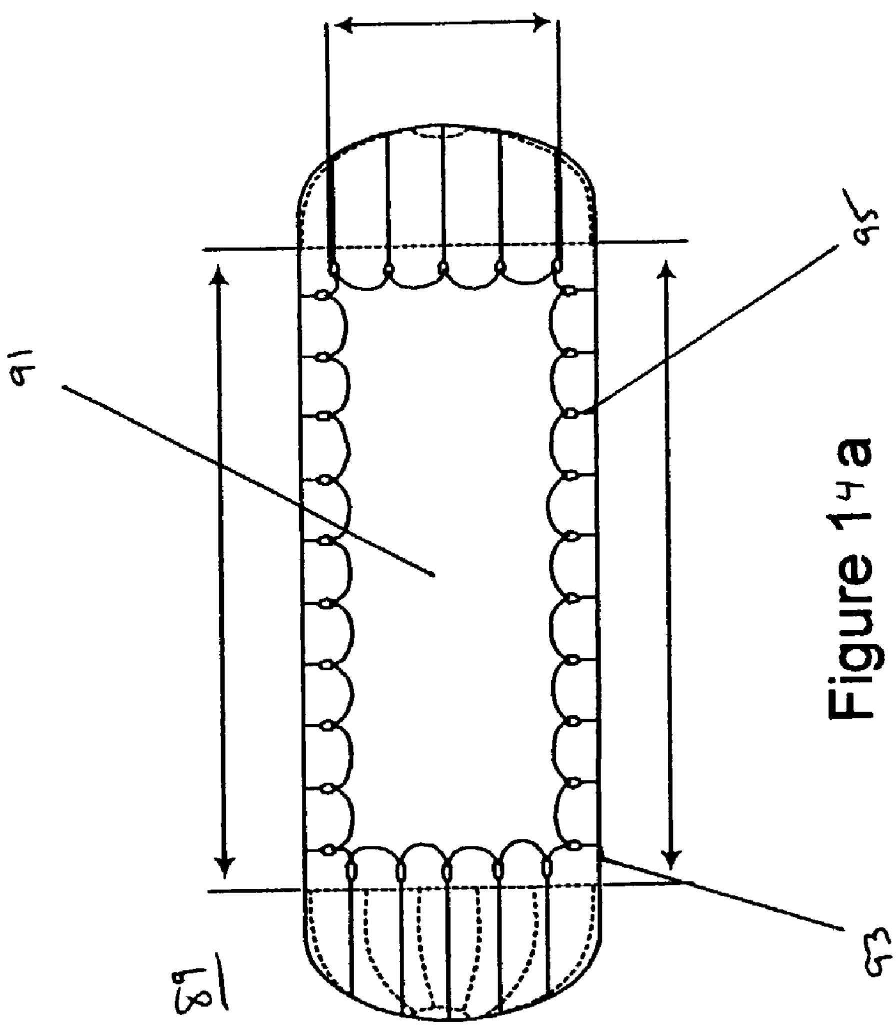

Figure 14a

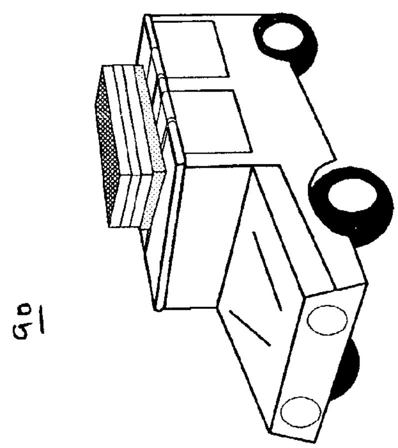

Figure 15a

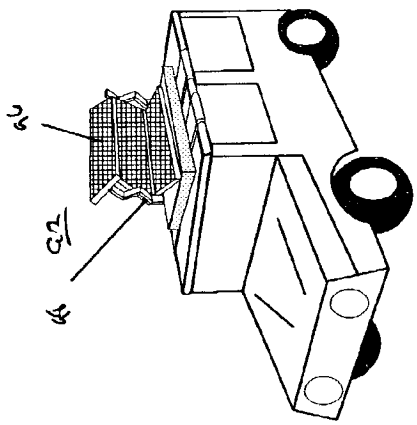

Figure 15b

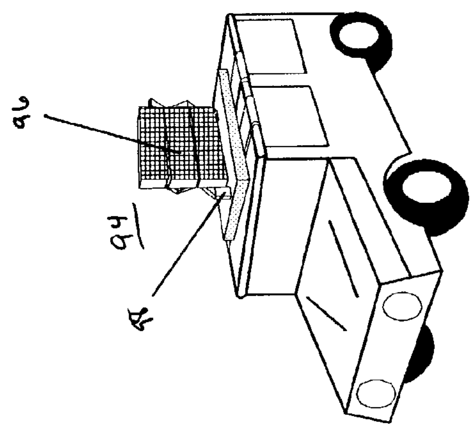

Figure 15c

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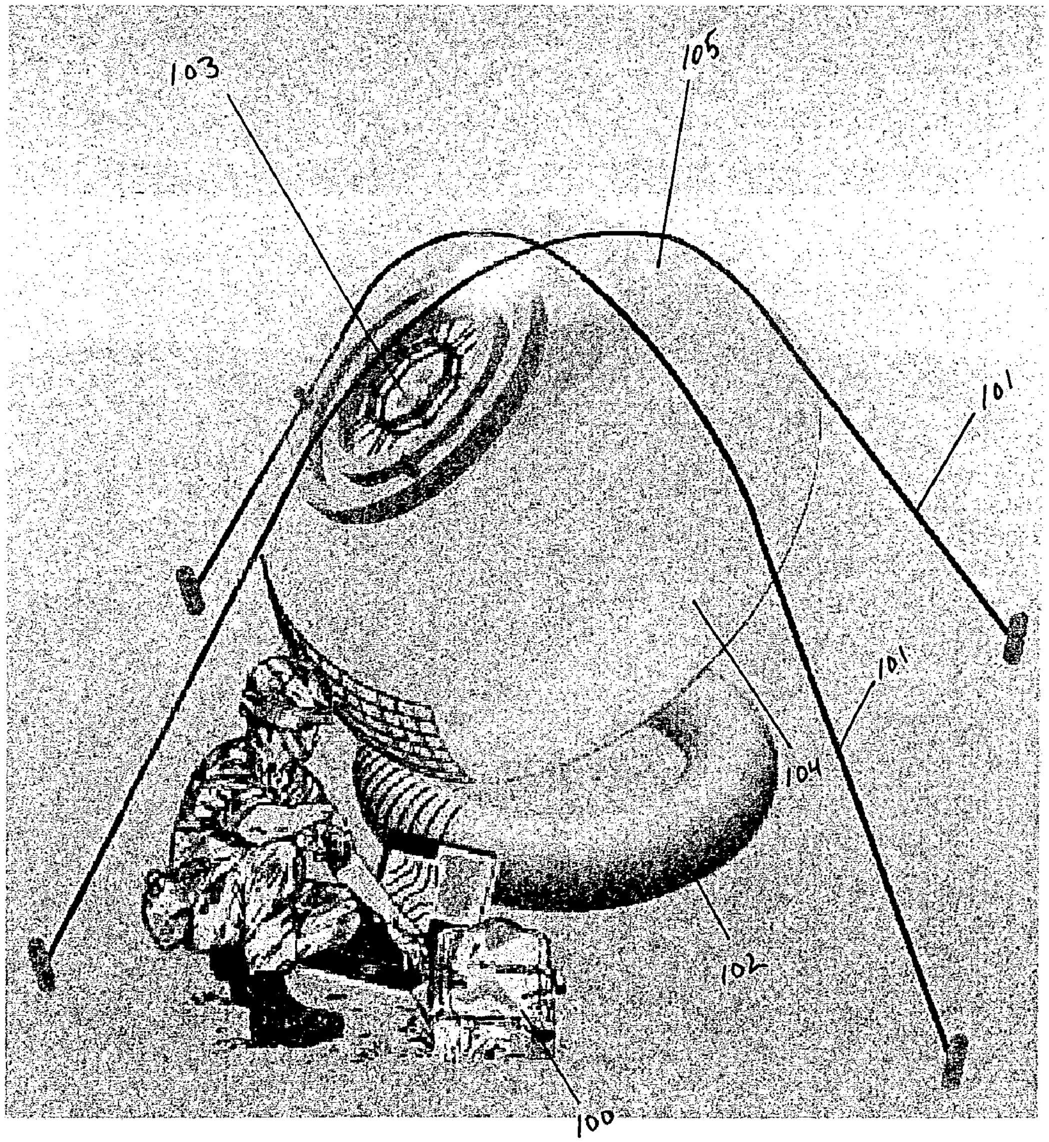

Figure 16

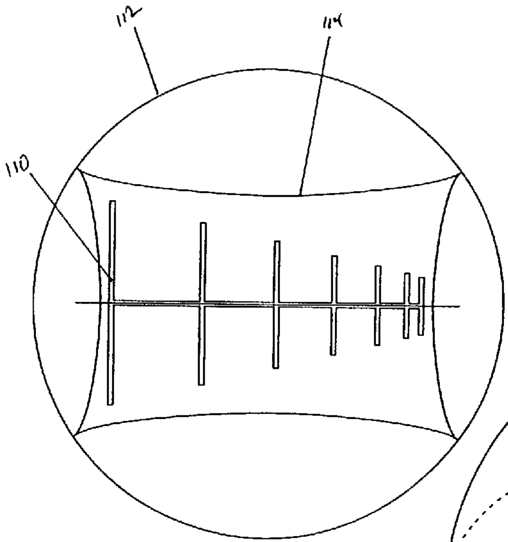

Figure 17a

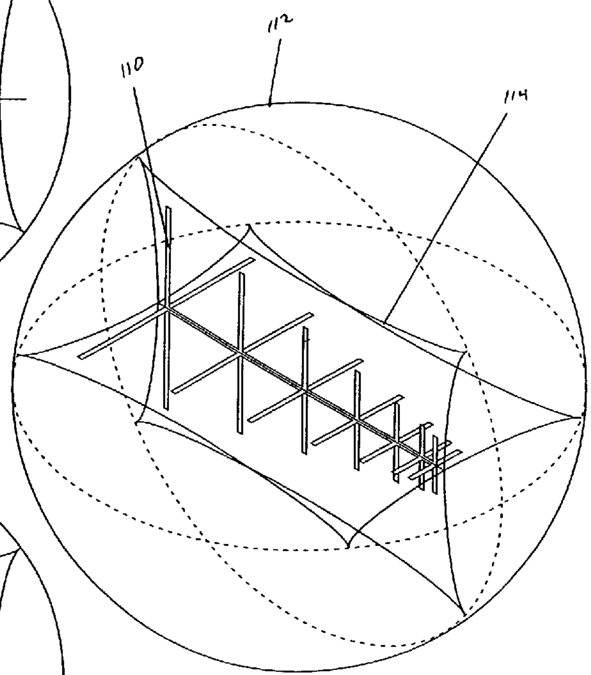

Figure 17c

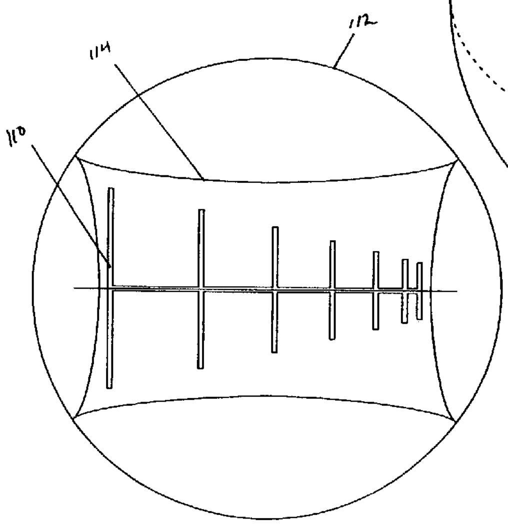

Figure 17b

INFLATABLE ANTENNA

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates generally to an antenna. More specifically, the present invention relates to an inflatable antenna that is stabilized with a radome.

2. Background Art

Antennas tend to be very sensitive elements of communications or radar systems. Correct alignment of the dish portion of the antenna is critical to proper operation. However, a large antenna dish can become unstable when exposed to environmental conditions such as wind. Typical solutions involve bracing and reinforcing the antenna system with a heavy support structure. While this approach works for fixed location antennas, it is difficult to implement for portable antennas. FIG. **1** shows an example of a prior art deployable satellite communications antenna **10**. The satellite dish **12** is braced by heavy beams **14** in order to keep the entire antenna properly aligned. The amount of weight and storage space required by such an antenna system is an impediment to quick and easy movement and assembly in locations that need satellite communications. Other solutions include using an antenna with a smaller dish size. While smaller antennas are more portable, their performance is not as good as that of larger antennas. Antenna performance characteristics such as the signal-to-noise ratio are dependent on the size and parabolic curvature of the antenna dish. Typically, a larger dish has better performance.

Light weight inflatable antennas have been demonstrated for use on orbital satellites. These inflatable antennas are large in size and have excellent performance characteristics. Since they are used in space, they are not subject to environmental conditions such as wind that can affect their alignment. However, because of the structural weakness resulting from their light weight, they are typically unsuitable for atmospheric use. Consequently, a need exists for a ground based inflatable antenna that is both stable and portable.

SUMMARY OF INVENTION

In some aspects, the invention relates to an antenna, comprising:

an inflatable dish; and an inflatable radome that surrounds the dish, where the radome stabilizes the orientation of the dish.

In other aspects, the invention relates to a phased-array antenna, comprising: at least one array of multiple radiator panels, where the panels are folded with off-set, self-aligning hinges; and an inflatable radome that surrounds the array, where the radome stabilizes the orientation of the array.

In other aspects, the invention relates to a phased-array antenna, comprising: an array of multiple radiator panels; an inflatable, cylindrical-shaped radome that surrounds the array, where the radome stabilizes the orientation of the array; and where the radiator panels are attached to the interior of the radome with multiple catenaries.

In other aspects, the invention relates to a phased-array antenna, comprising: an array of multiple radiator panels, where the panels are folded with off-set, self-aligning hinges; and a support frame that stabilizes the orientation of the array.

In other aspects, the invention relates to an antenna, comprising: a log periodic array antenna; and an inflatable radome that surrounds the log periodic array antenna, where the radome stabilizes the orientation of the log periodic array antenna.

In other aspects, the invention relates to an antenna, comprising: means for transmitting and receiving signals; and means for stabilizing the means for transmitting and receiving signals.

Other aspects and advantages of the invention will be apparent from the following description and the appended claims.

BRIEF DESCRIPTION OF DRAWINGS

It should be noted that identical features in different drawings are shown with the same reference numeral.

FIG. **1** shows a view of a prior art deployable satellite communications antenna.

FIG. **2***a* shows a cross-section view of a ground based inflatable antenna in accordance with one embodiment of the present invention.

FIG. **2***b* shows an alternative cross-section view of a ground based inflatable antenna in accordance with one embodiment of the present invention.

FIG. **2***c* shows a view of catenary connections for a lenticular dish in accordance with one embodiment of the present invention.

FIGS. **3***a* and **3***b* show an overhead and side view of a support cradle for the antenna shown in FIG. **2** in accordance with one embodiment of the present invention.

FIG. **4***a* shows a view of a standard feed horn used in accordance with one embodiment of the present invention.

FIG. **4***b* shows a view of an array feed used in accordance with an alternative embodiment of the present invention.

FIG. **5** shows a view of a vehicle with a fully deployed inflatable antenna and radome in accordance with one embodiment of the present invention.

FIGS. **6***a*, **6***b*, and **6***c* show progressive steps of deploying an inflatable antenna in accordance with one embodiment of the present invention.

FIGS. **7***a* and **7***b* show an inflatable torus and lenticular used with an antenna in accordance with one embodiment of the present invention.

FIG. **8** shows a deployed phased-array radar panel used in accordance with one embodiment of the present invention.

FIG. **9** shows a deploying phased-array radar panel with radome in accordance with one embodiment of the present invention.

FIG. **10** shows a deployable phased-array radar panel used in accordance with one embodiment of the present invention.

FIG. **11** shows two panels of a deployed phased-array antenna with self-aligning offset hinges in accordance with one embodiment of the present invention.

FIGS. **12***a* and **12***b* show two partially unfolded panels of a phased-array antenna with self-aligning offset hinges in accordance with one embodiment of the present invention.

FIG. **13***a* shows a cut away view of a vehicle with a single phased-array radar panel and radome in accordance with one embodiment of the present invention.

FIG. **13***b* shows a cut away view of a vehicle with triple phased-array radar panels and radome in accordance with one embodiment of the present invention.

FIGS. **14***a* and **14***b* show an alternative embodiment of a single phased-array array antenna panel and radome.

FIGS. **15***a*, **15***b*, and **15***c* show an alternative embodiment single panel phased-radar panel being extended on top of a vehicle.

FIG. **16** shows a man-portable antenna in accordance with one embodiment of the present invention.

FIGS. **17***a*, **17***b*, and **17***c* show an alternative embodiment of the present invention that uses a log-periodic antenna and a radome.

DETAILED DESCRIPTION

A ground-based inflatable antenna that may be used as part of a portable satellite communications system has been developed. The antenna may also be used for other applications such as radar or line-of-sight communications. FIG. **2***a* shows a cross-section view of an example of an antenna **16** in accordance with one embodiment of the present invention. The antenna includes an inflatable lenticular or "dish" **18** that is oriented towards a target such as a satellite. The dish **18** is surrounded by an inflatable radome **20**. The radome **20** is a spherical-shaped cover that provides protection for the dish **18** from environmental elements such as wind, etc. This allows the dish **18** to maintain proper alignment towards its target. The radome **20** is constructed of a flexible material or a membrane that is stable in ultraviolet light. A membrane is a thin, pliable sheet of natural or synthetic material that is supported by either mechanical tension or a pressure differential. The material should not interfere with the signals being generated or received by the antenna. Observation windows (not shown) made of clear material such as vinyl may be included on the surface of the radome **20** to allow visual inspection of the internal area of the antenna.

The radome **20** is supported by a cradle **22** that holds the antenna in position. The cradle **22** may attached to additional base structures such as a vehicle top or trailer. FIGS. **3***a* and **3***b* show respectively an overhead view and a side view of an example of a cradle **22**. The inter-connections from the antenna **16** to the other components of the system are made through an opening **30** in the bottom of cradle **22**.

Returning to FIG. **2***a*, access to the interior of the radome **20** is available through a port **26**. In this embodiment, the port is sealed with a zipper. The inflation and deflation of the antenna is controlled with an inflation tube **24** and an egress valve **25** respectively. A feed horn **28** for the dish **18** is located on the exterior of the radome **20**. It is supported entirely by the surface of the inflated radome without any additional structure. The dimensions of the radome are configured such that the feed horn is located at the focal point of the dish **18**. This configuration of the feed horn **28** with the dish **18** is called an "on-axis" or "prime focus" alignment. In alternative embodiments, other configurations of the feed and dish may be used such as: an offset alignment; a folded alignment (including both Gregorian and Cassegrain arrangements); and a hybrid of the offset and folded alignments.

The dish **18** may be constructed of two complementary, doubly-curved membranes. In FIG. **2***b*, the dish **18** is shown with a parabolic curved reflector membrane **21** and an RF-transparent parabolic canopy **23**. The concave sides of the membranes are joined at a bond band **27** to form a convex-shaped structure that is called the lenticular dish **18**. As shown in FIG. **2***c*, the lenticular dish **18** is held in place when the radome **20** is inflated by a series of catenaries **29** that are connected to the bond band **27** with grommets **31**.

FIGS. **4***a* and **4***b* show two examples of types of feeds that may be used with the present invention. FIG. **4***a* shows a radio frequency (RF) feed horn with a 90° bend **32**. Other embodiments may use different configurations and angles for a feed horn. The feed horn is mounted on the radome so that the opening **34** in the pyramid-shaped base faces down towards the dish of the antenna. FIG. **4***b* shows an array feed **36** that also may be mounted on the radome. The array feed **36** contains a series of identical elements **37** which can be used to form multiple signal beams or to electrically steer the antenna.

FIG. **5** shows an example of an inflatable antenna mounted on the top of a vehicle **38**. A cradle **42** is used to connect the radome **40** to the top of the vehicle. The antenna is inflated through a connection **44** in the side of the cradle **42**. A blower (not shown) is attached to the connection to provide a continuous flow of air to the antenna. In this example, the air flow from the blower should be continuous to the antenna in order to compensate for leakage of air from the radome through the material, zipper, observation panels, etc. The remaining components of the communication system are located in the vehicle and are connected to the antenna through the cradle **42**.

FIGS. **6***a*, **6***b*, and **6***c* show an example of how the antenna is carried and inflated. FIG. **6***a* shows a deflated antenna that is stowed away for easy transportation. The cradle **42** is attached to the top of a vehicle as previously shown in FIG. **5**. The cradle **42** and its cover **46** contain the collapsed deflated antenna. As shown FIG. **6***b*, once the vehicle arrives at its destination, a blower (not shown) is attached to the connection **44** on the side of the cradle **42** and the cover **46** is opened. As shown in FIG. **6***c*, once the blower is turned on, the antenna **48** begins to inflate. The inflation continues until the antenna is fully deployed. Once inflated, the air pressure inside the radome should be maintained to ensure mechanical stability of the antenna over vibration, wind gusts, gravity, etc.

The internal air pressure is typically maintained by a continuous air flow from the attached blower to compensate for leakage. However, if the radome is less prone to leakage, intermittent use of the blower could be used to periodically re-pressurize the antenna. The amount of internal air pressure is dependent on the expected amount of force to be exerted on the antenna. Such forces primarily include wind but also may include the weight of the horn that is supported by the radome. For example, an internal air pressure of about 0.1 pounds per square inch, gauge (PSIG) is sufficient to withstand the load of winds of 30 miles per hour (MPH) on a 5-meter diameter radome. Higher internal pressures may be used to withstand loads from higher winds. Additionally, the antenna may be secured by supplemental guy lines called "tethers" that attach to the exterior of the radome and are tied to a stable structure such as the vehicle or an in-ground stake. In an alternative embodiment, the exterior of the radome could be coated with a resin that would harden and cure when exposed to sunlight. This embodiment would typically not be re-stowed once it had been initially deployed and consequently would become a semi-permanent antenna.

FIGS. **7***a* and **7***b* show a perspective and frontal view respectively of an example of an inflatable torus **50** and lenticular or "dish" **52** used with the antenna. The torus **50** is an inflatable ring that fits within and is attached to the interior of the radome of the antenna. In alternative embodiments, the antenna could be used without the radome by securing it with separate support struts such as ground tethers, etc. When it is fully inflated and expanded, the torus **50** holds the dish **52** in place with a series of catenaries **54**. These catenaries are attached to both the torus **50** and the dish **52** with grommets. The size and parabolic arc of the dish is designed so that its focal point should be on the surface of the radome. The focal point will be where the feed is located. It is important to note that the dimensions of antennas will vary widely in different embodiments. However in the present example, the antenna has a diameter of 196 inches. The internal dish has a diameter of 189 inches (4.8 meters) with a focal length of about 120 inches and is supported from the spherical radome by a series of elastic retainers.

The lenticular dish may be formed by seaming two parabolic membranes together. One membrane is microwave-reflective and the other is non-reflective. The membranes may be made of light weight, thin polymers. The microwave-reflective composition of the dish of the antenna may be either a heterogeneous material or a homogenous material. The reflective membrane may be rendered reflective by coating it with metallizing paint. In one embodiment, metallizing paint is a heterogeneous material that includes silver metallic flake in an epoxy binder. In other embodiments, other conductive materials such as a homogeneous thin layer of aluminum or other microwave reflective materials could be used as a reflective coating. The non-reflective membrane is uncoated and transparent to RF signals. The membranes that make up the dish are about 1.00–1.25 mils thick. The heterogeneous reflective metallic coating for one of the membranes is about 100,000 Angstroms thick. Homogenous reflective coatings for the reflective membrane may be between 1,000–2,000 Angstroms thick.

FIG. **8** shows cross-section view of an alternative embodiment of the present invention that uses a phased array antenna **56**. A phased array antenna uses an array of identical radiators with the capability of altering the phase of the power fed to each of them. This allows the shape and direction of the radiation pattern to be altered without mechanical adjustment of the antenna. In FIG. **8**, the phased array antenna **56** has sixteen separate antenna panels **62**. Each panel **62** contains an array of smaller antennas or radiators. The antenna panels **62** are surrounded by a radome **58** in a similar manner as described in previous examples. The antenna is supported by a cradle **60** that may be attached to a supporting structure (not shown). Each panel **62** has a connection **64** with the other components of the system (not shown) through the interior of the cradle **60**.

The panels **62** are made of a light weight, rigid material and they are connected with each other with a series of off-set, self-aligning hinges. This configuration allows for the panels to fold up when being stowed away. FIG. **9** shows a cut-away view of the antenna panels **66** being folded up inside the deflated radome **68**. As shown in FIG. **10**, the antenna panels are arranged in four separate columns **70**, **72**, **74**, and **76** and four rows in each column **78**, **80**, **82** and **84**. When the antenna is stowed, the columns and rows all fold simultaneously with each other. The twelve panels on the exterior edge of the antenna are connected to the interior of the radome by flexible cords. As the radome inflates, these cords pull the panels apart from their folded configuration. Once the radome is fully deployed, the panels are fully extended into a single panel. The off-set, self-aligning hinges are used to compensate for the thickness of the individual panels.

FIG. **11** shows two panels **71** of a deployed phased-array antenna with an off-set, self-aligning hinge **73**. The hinge allows the panels of the antenna to fold in an "Origami-style" technique. This means that the panels **71** fold and unfold simultaneously when force is applied instead of being able to fold or unfold one column or row at a time. The origami folding technique ensures that all of the panels of the antenna will fully deploy when the antenna is unfolded.

Likewise, all of the panels of the antenna will fully fold up when the antenna is packed up.

FIGS. **12***a* and **12***b* show two partially folded panels of a phased-array antenna with off-set, self-aligning hinges. An electrical connector (not shown) is located on the edges of the body of the panels **71**. It is used to make an electrical connection between the panels **71**. The connector may be a spring contact connector for direct current (DC) connections or a capacitive coupled co-axial connector for radio frequency (RF) connections. Other types of connectors that are known in the art could be used in alternative embodiments. The self-aligning hinge **73** is shown with a cross member **79** that spans across the seam **75** of the two panels **71**. The cross member **79** connects to each panel by cantilever struts **81** with a pivoting or flexing-membrane hinge. Each folding connector **81** is attached to its respective panel **71**. When the panels are fully deployed, the cantilever struts **81** fold underneath the cross member **79** and the entire hinge **73** seats flush across the seam **75** of the panels **71** in a recessed slot. When the panels are unfolded, the cantilever struts **81** fold out from under the cross member **79** and allow the panels **71** to move.

FIGS. **13***a* and **13***b* show cut away views of alternative embodiments of deployed phased array antennas. FIG. **13***a* shows a fully deployed single plane phased array antenna **86** that is mounted on the top of a vehicle. FIG. **13***b* shows a fully deployed triple plane phased array antenna **88** that is also mounted on top of a vehicle. In this embodiment, three identical phased array antennas are configured at an angle of 120° with respect to each other. This arrangement provides full 360° coverage without having to re-orient the antenna's direction. Alternative embodiments could use varying numbers of panels that are equidistantly angled for 360° coverage. For example, four panels could be used that are arranged at a 90° angle with respect to each other.

FIGS. **14***a* and **14***b* show cross sectional views of another embodiment of a deployed phased array antenna. In this embodiment, the antenna **89** is cylindrically shaped. The radome **93** is an inflatable elongated cylinder with dome-shaped cap on each end. The antenna panels **91** are suspended in the radome **93** with multiple flexible centenaries **95**. This embodiment of an inflatable antenna may be deployed on the back of a trailer or fixed on the ground with guy lines to hold it in position.

FIGS. **15***a*, **15***b* and **15***c* show an alternative embodiment of a phased array antenna being deployed. In this embodiment, the phased array antenna panels are not surrounded by a radome, but instead they are held in place with a support frame. The antenna may use the off-set, self-aligning hinges described previously. FIG. **15***a* shows the phased array antenna in a stowed configuration **90** on top of a vehicle. As shown in FIG. **15***b*, once the vehicle arrives on station, the panels of the antenna **96** are deployed by extending the support frame **98**. FIG. **15***b* shows the antenna **94** fully extended and braced by the support frame **98**. The antenna may also be retracted and stowed in a similar manner. In alternative embodiments, the antenna could be mounted on a rotating base so that the orientation may be changed without moving the vehicle. In other embodiments, the antenna could have multiple phased array panels to provide 360° coverage as previous shown and described in FIG. **13***b*.

In alternative embodiments, the present invention could be deployed in a man-portable configuration. FIG. **16** shows a man-portable antenna **99** that is carried in a backpack **100** and tethered to the ground **101** when deployed. In this embodiment, the antenna is supported on an inflatable torus **102** and uses an array feed **103** with the inflatable lenticular

104 inside a spherical radome **105**. Alternatively, the radome of the antenna could be filled with helium, etc. and lifted in the air. Ground tethers would be used to secure the antenna to the ground. In other embodiments, the present invention could be used on aeronautical vehicles such as blimps or other types of aircraft as well as orbital satellites.

FIGS. **17***a*–**17***c* show an alternative embodiment of the present invention that uses a log-periodic antenna. FIGS. **17***a* and **17***b* show a top view and a front view of the antenna respectively. FIG. **17***c* shows a perspective view of the embodiment. This antenna contains a cross-polarized, log periodic array (LPA) antenna **110** that is inside an inflatable radome **112**. The LPA **110** could be printed elements on membranes **114** as shown. In alternative embodiments, the LPA **110** could be wire antennas that are held in place and supported by non-conducting catenaries. In other embodiments, multiple LPA **110** could be mounted inside one radome **112**.

The present invention has the advantages of being a light weight, transportable antenna for ground based use. Both the inflatable reflector and foldable phased array antennas offer significant improvements in weight and stowage space used over conventional antennas. While the invention has been described with respect to a limited number of embodiments, those skilled in the art, having benefit of this disclosure, will appreciate that other embodiments can be devised which do not depart from the scope of the invention as disclosed here. Accordingly, the scope of the invention should be limited only by the attached claims.

What is claimed is:

1. An antenna, comprising:

an inflatable dish;

an inflatable radome that surrounds the dish, where the radome stabilizes the orientation of the dish;

a window that allows observation of the interior of the radome; and

a port that allows access to the interior of the radome.

2. The antenna of claim **1**, where the port is opened and closed with a zipper.

3. An antenna, comprising:

an inflatable dish;

an inflatable radome that surrounds the dish, where the radome stabilizes the orientation of the dish; and

a feed that is mounted on the surface of the radome.

4. The antenna of claim **3**, where the feed is an RF feed horn.

5. The antenna of claim **3**, where the feed is an array feed.

6. The antenna of claim **3**, where the dish and radome are inflated with an external blower.

7. The antenna of claim **6**, where blower generates a continuous air flow.

8. The antenna of claim **3**, where the dish comprises a first membrane and a second membrane.

9. The antenna of claim **8**, where the first membrane is coated with a conductive material and the second membrane is transparent to RF signals.

10. The antenna of claim **9**, where the conductive material is a metallized paint comprising silver flakes.

11. The antenna of claim **3**, further comprising:

an inflatable torus that is attached to the interior of the radome, where the torus holds the dish in proper orientation.

12. The antenna of claim **3**, where the radome is coated with a resin that cures to harden the radome.

13. The antenna of claim **3**, where the antenna is further stabilized by guy lines that attach the exterior of the radome to a fixed structure.

14. A phased-array antenna, comprising:

at least one array of multiple radiator panels, where the panels are folded with off-set, self-aligning hinges comprising a cross member and a cantilever strut that attaches the cross member to a radiator panel; and

an inflatable radome that surrounds the array, where the radome stabilizes the orientation of the array.

15. The antenna of claim **13**, further comprising multiple separate panels of arrays of multiple radiator panels, where the panels are oriented at angles to provide 360 degrees of coverage.

16. The antenna of claim **13**, further comprising three separate panels of arrays of multiple radiator panels, where the panels are oriented at a 120 degree angle with respect to each panel.

17. A phased-array antenna, comprising:

an array of multiple radiator panels;

an inflatable, cylindrical-shaped radome that surrounds the array, where the radome stabilizes the orientation of the array; and

where the radiator panels are attached to the interior of the radome with multiple catenaries.

18. A phased-array antenna, comprising:

an array of multiple radiator panels, where the panels are folded with off-set, self-aligning hinges comprising a cross member and a cantilever strut that attaches the cross member to the array of multiple radiator panels; and

a support frame that stabilizes the orientation of the array.

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