

Nov. 19, 1957

C. J. MILLER

2,814,038

LIGHTWEIGHT ANTENNAS

Filed July 29, 1953

Fig. 1.

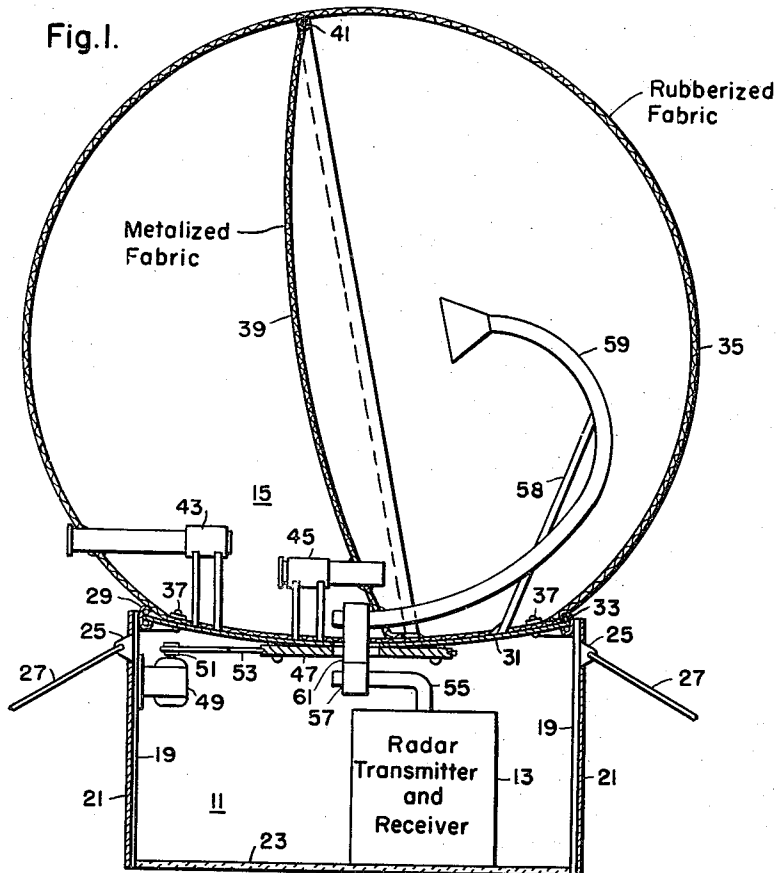


Fig. 2.

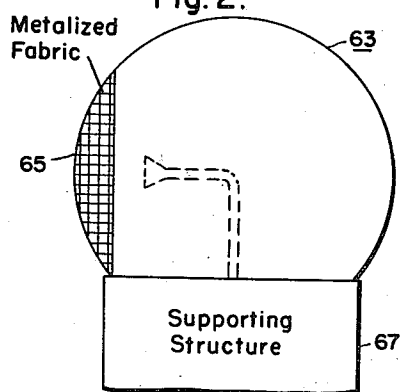
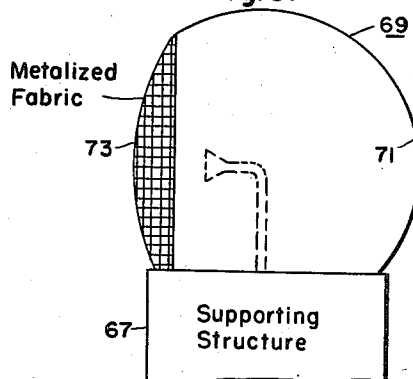


Fig. 3.



WITNESSES:

E. A. M. Lasky

Wm. T. Wofford

INVENTOR

Coleman J. Miller.

BY

F. E. Browder
ATTORNEY

1

2,814,038

LIGHTWEIGHT ANTENNAS

Coleman J. Miller, Catonsville, Md., assignor to Westinghouse Electric Corporation, East Pittsburgh, Pa., a corporation of Pennsylvania

Application July 29, 1953, Serial No. 371,093

41 Claims. (Cl. 343—757)

My invention relates to antennas, and particularly to antennas which are light in weight and of a type suitable for use in the transmission and reception of high frequency electromagnetic wave energy.

It is an object of my invention to provide antennas of the type suitable for use in the transmission and reception of high frequency electromagnetic wave energy, which antennas shall have only a fraction of the weight of those heretofore known.

Another object of my invention is to provide antennas for use in the transmission and reception of electromagnetic wave energy and of the type utilizing reflector surfaces, and which shall be very light in weight for a given size of reflector surface.

Another object of my invention is to provide antennas for use in transmission and reception of high frequency electromagnetic wave energy and of the type utilizing a reflecting surface, and which antennas may be highly directional and large in size and yet light in weight and easily transportable.

These and other objects are effected by my invention as will be apparent from the following description taken in accordance with the accompanying drawings, forming a part of this application, in which:

Figure 1 is a schematic plan view, partly in section, showing a preferred embodiment of my invention; and Figs. 2 and 3 are sketches illustrating some modifications of Fig. 1.

In the prior art it has been known to protect antennas, particularly airborne antennas, by covering them with radomes. Some radomes have been made in the form of an inflated balloon of rubberized fabric, using air pressure for mechanical strength. My invention contemplates the use of an inflatable structure, not merely to protect or house an antenna, but to be actually a part of the antenna itself. In accordance with the principles of my invention part of an inflated structure is made of material suitable for reflection of high frequency electromagnetic wave energy and is of such shape as to constitute an effective antenna reflector.

My invention is particularly advantageous in applications involving antenna structures which must be highly directional, large, and easily transportable. Fig. 1 is illustrative of my invention as it may be applied to an early warning type ground radar installation.

With reference to Fig. 1, an enclosure 11 performs the dual function of housing suitable transmitting and receiving radar apparatus 13, and supporting the antenna assembly 15. The specific construction of the enclosure forms no part of my invention and need not be shown and described in detail herein. The desirable characteristics of the enclosure are that it should be light in weight, easy to assemble or disassemble, and readily transportable. In Fig. 1 the sides of the enclosure comprise a framework including upright support members 19. These upright support members 19 are fixed to bracing members not shown. The enclosure side framework is covered by a suitable light weight material 21 shown as

2

thin gauge sheet metal, but which may be fabric, plastic or other suitable material. The floor 23 of the enclosure is shown as masonry, but may be wood, light metal, or other suitable material. The enclosure 11 is preferably made cylindrical in form to provide the most convenient arrangement for the antenna bearing support structure. Some of the enclosure framework upright support members 19 have suitable brackets 25 fixed to their upper portions and extending through openings in the framework cover. Guyrods, or wires 27 are fixed to these brackets 25 so that the enclosure 11 may be firmly anchored to surrounding earth or other support. Fixed on the inside face of the enclosure framework upright members 19 is an annular bearing support ring 29 of C-shaped cross section. The roof of the enclosure comprises a member 31 in the shape of a disc having its peripheral edges inserted in the C-shaped bearing support ring 29. Ball bearings 33 are located above and below the disc member 31 within the bearing ring 29. The enclosure roof member is shown as metal, slightly concave, but may be made of other suitable materials, and could be flat, or even convex. A balloon 35 made of flexible inflatable fabric, shown as rubberized fabric, is centered and fixed on top of the enclosure roof. As shown in Fig. 1 the balloon 35 is spherical, but it may obviously take other suitable shapes. The balloon may be a complete sphere, fixed to the enclosure roof by spaced clamps 37 as shown in the drawing, or it may be sealed to the enclosure roof by a circular clamping ring and have the portion within the ring cut out. The seal of course need only be sufficiently tight to allow convenient inflation of the balloon. A wall or partition 39 made of flexible inflatable material is located inside the balloon 35. The wall material is shown in the drawing as metallized fabric, but it may be any flexible inflatable material which is capable of effectively reflecting high frequency electromagnetic wave energy. The partition 39 is shaped to take the form of a parabolic surface, and it constitutes the antenna reflector. The partition 39 shown in the drawing has an inflatable hose 41 fixed to its peripheral edge. This hose 41 when inflated bears against the inner surface of the balloon 35 and retains the partition 39 in proper shape and position. The hose may be inflated by any suitable means, and in some cases may use air or gas from a pressurized wave guide system. In the drawing, the hose 41 is shown as only a partial ring anchored at its ends to the enclosure roof member 31. Obviously, if the roof had sufficient curvature, the hose 41 could be a complete ring. The reflector 39 shown in the drawing is not a complete parabola since its bottom portion is limited by the enclosure roof curvature. It is of course not essential that the reflector 39 be a complete parabola, and in some cases the lower part of the reflector may even be non-conducting fabric, depending upon the size and configuration of the reflecting surface desired. Further, it is not essential that an inflatable rubber ring 41 be used to retain the reflector in place. The reflector edge may be sealed to the inner surface of the balloon 35 by various suitable means. The left-hand compartment of the balloon structure is inflated by means of a blower 43 which draws air through the balloon wall. The right-hand partition of the balloon structure is inflated by a blower 45 which draws air from the left-hand compartment. The blowers are supported by the enclosure roof member 31, and are supplied power from a suitable source, not shown. The blower outputs are adjusted so that there will always be a higher pressure in the right-hand compartment than in the left-hand compartment. It is this pressure differential which forces the reflector 39 to assume its intended shape. As has been indicated in the description above, the enclosure roof member 31 and the antenna assembly

15 are mounted for movement with respect to the rest of the enclosure. Motive power for such movement may be supplied by a motor and pulley arrangement. One large pulley 47 may be suitably fixed to the inside of the enclosure roof member 31. The pulley center is made to coincide with the roof center. A motor 49 is shown mounted to the enclosure side wall framework in position to drive the large pulley 47 through a small pulley 51 and belt 53. There are of course many possible means by which the antenna assembly 15 could be driven, and the drive shown in the drawing is for illustrative purposes only. The purpose of the antenna assembly drive is of course to impart scanning motions to the antenna. The drive may incorporate oscillatory as well as rotary motions. The enclosure houses conventional radar transmitting and receiving apparatus which is shown in the drawing as a block 13. The feed mechanism for the antenna reflector 39 comprises a wave guide 55 connecting the radar transmitter and receiver through a rotary joint 57 to a conventional feed-horn 59. The feed horn is supported by suitable bracing members 58. The rotary joint 57 has one section 61 fixed to the enclosure roof member 31. The axis of rotation of the rotary joint 57 coincides with the axis of rotation of the roof member 31 and antenna reflector assembly 15.

Fig. 2 illustrates a modification of the apparatus shown in Fig. 1. The apparatus shown in Fig. 2 is similar in all respects to that shown by Fig. 1 except that the partition wall has been dispensed with and a portion of the surface of the balloon 63 is made of flexible inflatable conducting material and constitutes the antenna reflector 65. The block 67 labelled supporting structure corresponds to the enclosure assembly shown in Fig. 1, including radar apparatus, the roof and antenna bearing assembly and waveguide rotary joint. In Fig. 2, of course, a second blower is not necessary, and the antenna feed mechanism is suitably modified. The surface of the reflector 65 shown in Fig. 2 is approximately parabolic since it is a relatively small section of a spherical surface.

In Fig. 3 there is shown a further modification of the apparatus shown in Fig. 1. In Fig. 3 the balloon 69 is shaped so that one section 71 has a spherical surface and the other section 73 has a parabolic surface. The section 73 having a parabolic surface is made of conducting material and constitutes the antenna reflector.

It is understood that the balloon structures shown in the drawings may not have exactly spherical surfaces but may be spheroids, or have other suitable shapes. It is also understood that the antenna reflectors may be made of any suitable material which is flexible, inflatable, and capable of effective reflections of high frequency electromagnetic wave energy.

While I have shown my invention in several forms, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various changes and modifications without departing from the spirit thereof.

I claim as my invention:

1. In an antenna system, an inflatable housing of non-conducting material, a reflector of flexible conducting material arranged inside said housing to assume a predetermined position when said housing is inflated, a feed mechanism for said reflector, and means allowing movement of said housing with respect to a supporting structure to impart scanning motions to said reflector.

2. In an antenna system, an inflatable structure comprising flexible inflatable material part of which is conductive and part of which is non-conductive, and wherein the conductive part constitutes an antenna reflector, and means located within said structure for feeding wave energy to said reflector.

3. In an antenna system, the combination comprising an inflatable housing structure including flexible inflatable material part of which is conductive and part of which

is non-conductive and wherein the conductive part constitutes an antenna reflector, and a feed mechanism for said reflector.

4. In an antenna system, an inflatable structure comprising flexible inflatable material part of which is conductive and part of which is non-conductive, and wherein the conductive part constitutes an antenna reflector and forms an inner wall which divides said structure into a plurality of dissimilarly pressurized compartments.

5. In an antenna system, an inflatable structure comprising flexible inflatable material part of which is conductive and part of which is non-conductive, and wherein the conductive part constitutes an antenna reflector and forms an outer wall of said structure.

6. In an antenna system, an inflatable housing of flexible non-conductive material, and flexible inflatable conducting material forming a partition in said housing to divide the same into dissimilarly pressurized compartments, said partition constituting an antenna reflector.

7. In an antenna system, an inflatable housing of flexible non-conducting material, flexible inflatable conducting material forming an inner wall dividing said housing into two inflatable compartments and constituting an antenna reflector, and means for maintaining a pressure differential between said compartments.

8. In an antenna system, an inflatable generally spherical housing of non-conducting material, a substantially parabolic reflector of flexible conducting material arranged inside said housing to assume a predetermined position when said housing is inflated, a feed mechanism for said reflector, and means allowing movement of said housing with respect to a supporting structure to impart scanning motions to said reflector.

9. In an antenna system, an inflatable structure, flexible inflatable material part of which is conductive and part of which is non-conductive forming an outer wall of generally spheroidal shape for said structure, and wherein the conductive part constitutes a substantially parabolic antenna reflector.

10. In an antenna system, an inflatable housing of flexible non-conductive material generally spheroidal in shape, and flexible inflatable conducting material forming a partition in said housing and constituting a substantially parabolic antenna reflector, said partition dividing said housing into two differentially pressurized chambers.

11. In an antenna system, an inflatable housing of flexible non-conducting material and generally spheroidal in shape, flexible inflatable conducting material forming an inner wall dividing said housing into two inflatable compartments and constituting a substantially parabolic antenna reflector and means for maintaining a pressure differential between said compartments.

12. In an antenna system, an inflatable structure generally spherical in shape comprising flexible inflatable material part of which is conductive and part of which is non-conductive, and wherein the conductive part constitutes a substantially parabolic antenna reflector, feed mechanism for said reflector, support means for said structure, and means allowing movement of said structure with respect to said support means to impart scanning motions to said reflector.

13. In an antenna system, an inflatable structure, flexible inflatable material part of which is conductive and part of which is non-conductive forming an outer wall of generally spheroidal shape for said structure, and wherein the conductive part constitutes a substantially parabolic antenna reflector, feed mechanism for said reflector, support means for said structure, and means allowing movement of said structure with respect to said support means to impart scanning motions to said reflector.

14. In an antenna system, an inflatable housing of flexible non-conductive material generally spheroidal in shape, and flexible inflatable conducting material forming a partition in said housing and constituting a substantially parabolic antenna reflector, feed mechanism for said re-

flector, support means for said structure, and means allowing movement of said structure with respect to said support means to impart scanning motions to said reflector.

15. In an antenna system, an inflatable housing of flexible non-conducting material and generally spheroidal in shape, flexible inflatable conducting material forming an inner wall dividing said housing into two inflatable compartments and constituting a substantially parabolic antenna reflector, and means for maintaining a pressure differential between said compartments, feed mechanism for said reflector, support means for said structure, and means allowing movement of said structure with respect to said support means to impart scanning motions to said reflector.

16. In an antenna system, an inflatable structure, the outer wall for said structure being made up of a first surface section of flexible inflatable non-conducting material having a substantially spherical surface and a second section of flexible inflatable conducting material having a substantially parabolic surface, said second surface section constituting an antenna reflector.

17. An inflatable structure having a portion of its outer wall metallized to form an antenna reflector, and wave energy feed mechanism for said reflector.

18. An inflatable structure having a portion of its surface metallized to form an antenna reflector, feed mechanism for said reflector, and means supporting said reflector to effect antenna scanning.

19. An inflatable structure having a flexible inner partition dividing said structure into two dissimilarly pressurized compartments, said inner partition having at least a portion of its surface metallized and shaped to form an antenna reflector.

20. An inflatable structure having a flexible inner partition dividing said structure into two separate inflatable compartments, said inner partition having at least a portion of its surface metallized and shaped to form an antenna reflector, and means for maintaining a pressure differential between said compartments.

21. In an antenna system, an inflatable housing of flexible non-conducting material, flexible inflatable conducting material forming an inner wall dividing said housing into two inflatable compartments and constituting an antenna reflector, an inflatable ring fixed to a peripheral portion of said inner wall and dimensioned to bear against the outer wall of said housing to support said inner wall when inflated, and means for maintaining a pressure differential between said compartments.

22. In an antenna system, an inflatable housing of flexible non-conducting material, flexible inflatable conducting material forming an inner wall dividing said housing into two inflatable compartments and constituting an antenna reflector, an inflatable ring section fixed to a peripheral portion of said inner wall and dimensioned to bear against the outer wall of said housing to support said inner wall when inflated, and means for maintaining a pressure differential between said compartments.

23. In an antenna system, an inflatable housing of flexible non-conducting material and generally spheroidal in shape, flexible inflatable conducting material forming an inner wall dividing said housing into two inflatable compartments and constituting a substantially parabolic antenna reflector, an inflatable ring fixed to a peripheral portion of said inner wall and dimensioned to bear against the outer wall of said housing to support said inner wall when inflated, and means for maintaining a pressure differential between said compartments.

24. In an antenna system, an inflatable housing of flexible non-conducting material and generally spheroidal in shape, flexible inflatable conducting material forming an inner wall dividing said housing into two inflatable compartments and constituting a substantially parabolic antenna reflector, an inflatable ring section fixed to a peripheral portion of said inner wall and dimensioned to bear against the outer wall of said housing to support

said inner wall when inflated, and means for maintaining a pressure differential between said compartments.

25. An inflatable balloon section sealed to a base member and having a wall portion made of high frequency wave energy reflective material and shaped to constitute an antenna reflector, and means for rotating said base member to effect scanning movement of said reflector.

26. In an antenna system, an inflatable structure comprising a base portion of substantially rigid material, an inflatable portion of flexible inflatable material sealed to said base portion, part of said flexible material being metallized to constitute an antenna reflector, and means extending through said base portion and into said inflatable portion for feeding wave energy to said antenna.

27. In an antenna system, an inflatable structure comprising a base portion of substantially rigid material, an inflatable portion of flexible inflatable material sealed to said base portion, part of said flexible material being metallized to constitute an antenna reflector, feed mechanism for said reflector, and means for mounting said base member for movement to impart scanning motions to said reflector.

28. In an antenna system, an inflatable housing comprising a base portion of substantially rigid material and an inflatable portion of flexible inflatable material sealed to said base portion, flexible inflatable material forming a partition to divide said housing into two compartments, at least part of said partition material being metallized to constitute an antenna reflector, and means for imparting movement of said base portion to effect scanning action of said antenna reflector.

29. In an antenna system, an inflatable housing comprising a base portion of substantially rigid material and an inflatable portion of flexible inflatable material sealed to said base portion, flexible inflatable material forming a partition to divide said housing into two compartments, at least part of said partition material being metallized to constitute an antenna reflector, feed mechanism for said reflector, and means for mounting said base member for movement to impart scanning motions to said reflector.

30. In an antenna system, an inflatable housing comprising a base portion of substantially rigid material and an inflatable portion of flexible inflatable material sealed to said base portion, flexible inflatable material forming a partition to divide said housing into two compartments, at least part of said partition material being metallized to constitute an antenna reflector, feed mechanism for said reflector, and means for maintaining a pressure differential between said compartments.

31. In an antenna system, an inflatable housing comprising a base portion of substantially rigid material and an inflatable portion of flexible inflatable material sealed to said base portion, flexible inflatable material forming a partition to divide said housing into two compartments, at least part of said partition material being metallized to constitute an antenna reflector, and means for maintaining a pressure differential between said compartments.

32. In an antenna system, an inflatable housing comprising a base portion of substantially rigid material and an inflatable portion of flexible inflatable material sealed to said base portion, flexible inflatable material forming a partition to divide said housing into two compartments, at least part of said partition material being metallized to constitute an antenna reflector, feed mechanism for said reflector, and one or more inflatable ring sections fixed to the peripheral edge of said partition material and dimensioned to bear against the outer wall of said housing when inflated, so as to support said partition relative to said outer wall.

33. In an antenna system, an inflatable structure comprising a base portion of substantially rigid material, an inflatable portion of flexible inflatable material having a substantially spheroidal surface and sealed to said base

portion, part of said flexible material being metallized to constitute an antenna reflector.

34. In an antenna system, an inflatable structure comprising a base portion of substantially rigid material, an inflatable portion of flexible inflatable material having a substantially spheroidal surface and sealed to said base portion, part of said flexible material being metallized to constitute an antenna reflector, feed mechanism for said reflector, and means for mounting said base member for movement to impart scanning motions to said reflector.

35. In an antenna system, an inflatable housing comprising a base portion of substantially rigid material and an inflatable portion of flexible inflatable material having a substantially spheroidal surface and sealed to said base portion, flexible inflatable material forming a partition to divide said housing into two compartments, at least part of said partition material being metallized to constitute an antenna reflector of substantially parabolic shape.

36. In an antenna system, an inflatable housing comprising a base portion of substantially rigid material and an inflatable portion of flexible inflatable material having a substantially spheroidal surface and sealed to said base portion, flexible inflatable material forming a partition to divide said housing into two compartments, at least part of said partition material being metallized to constitute an antenna reflector of substantially parabolic shape, and means for maintaining a pressure differential between said compartments.

37. In an antenna system, an inflatable housing comprising a base portion of substantially rigid material and an inflatable portion of flexible inflatable material having a substantially spheroidal surface and sealed to said base portion, flexible inflatable material forming a partition to divide said housing into two compartments, at least part of said partition material being metallized to constitute an antenna reflector of substantially parabolic shape, feed mechanism for said reflector, and one or more

inflatable ring sections fixed to the peripheral edge of said partition material and dimensioned to bear against the outer wall of said housing when inflated, so as to support said partition relative to said outer wall.

38. In an antenna system, the combination of a housing structure having at least a portion of its outer wall formed from flexible conductive material, means for maintaining a pressure differential between the interior and exterior of said housing structure whereby the conductive material will become curved to form an antenna reflector, and wave energy feed mechanism for said reflector.

39. In an antenna system, a generally circular sheet of flexible material having at least a portion of its surface metallized, an inflated ring section fixed to the outer periphery of said sheet of flexible material for supporting the same, and means for maintaining a pressure differential between opposite sides of said flexible material whereby the material will become curved to form an antenna reflector.

40. In an antenna system, a sheet of flexible material having at least a portion of its surface metallized, a member fixed to the outer periphery of said sheet of flexible material for supporting the same, and means for maintaining a pressure differential between opposite sides of said flexible material whereby the material will become curved to form an antenna reflector.

41. In an antenna system, a sheet of flexible material having at least a portion of its surface metallized to form an antenna reflector, and an inflatable tubular member secured to the outer periphery of said sheet for supporting the same when the tubular member is inflated.

References Cited in the file of this patent

UNITED STATES PATENTS

2,428,793	Fay	Oct. 14, 1947
2,463,517	Chromak	Mar. 8, 1949
2,560,218	Dunlap	July 10, 1951