CROSS REFERENCE SEARCH ROO

Jan. 10, 1967 M. SULITEANU 3,296,685

METHOD OF MAKING DIELECTRIC FOAM ANTENNA

Original Filed May 31, 1962 6 Sheets-Sheet 1

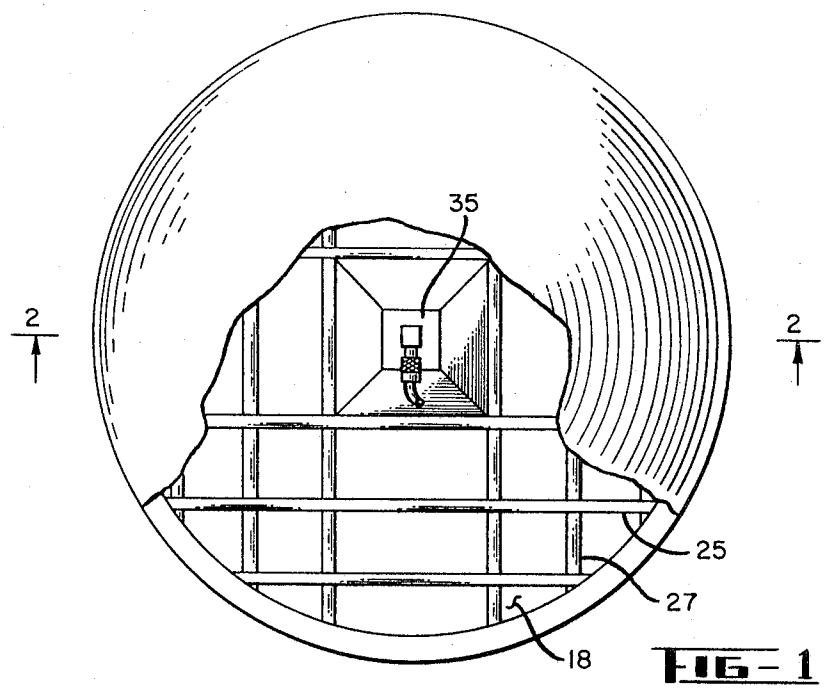

FIG-1

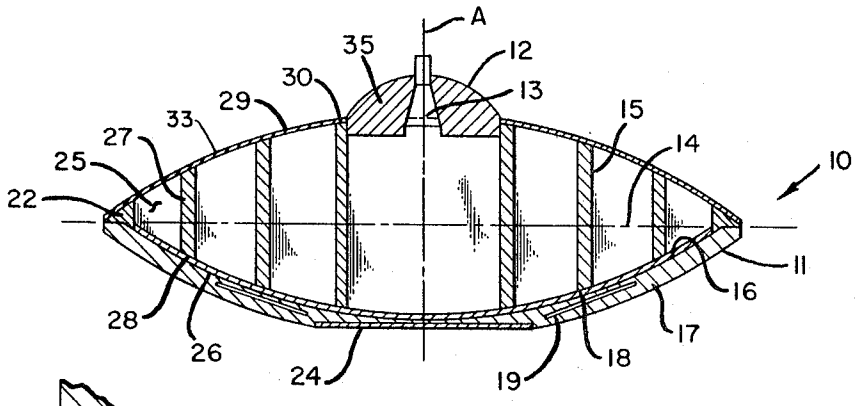

FIG-2

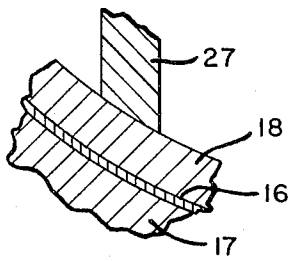

FIG-3

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METHOD OF MAKING DIELECTRIC FOAM ANTENNA

Original Filed May 31, 1962 6 Sheets-Sheet 2

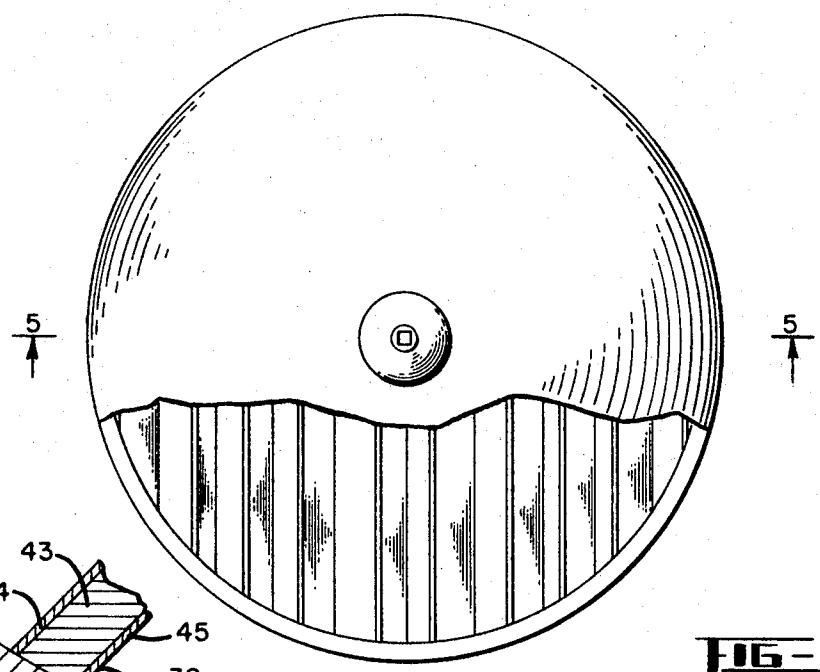

FIG-4

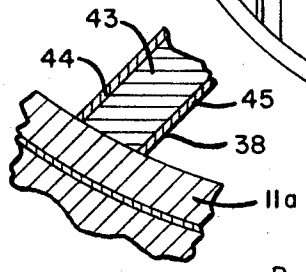

FIG-6

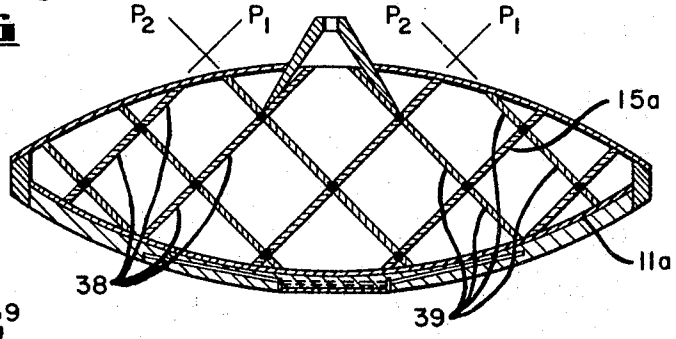

FIG-5

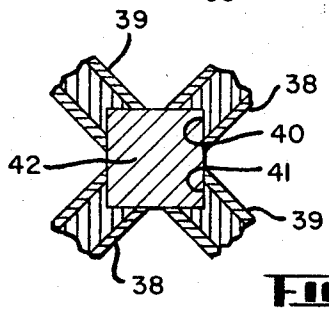

FIG-7

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METHOD OF MAKING DIELECTRIC FOAM ANTENNA

Original Filed May 31, 1962 6 Sheets-Sheet 3

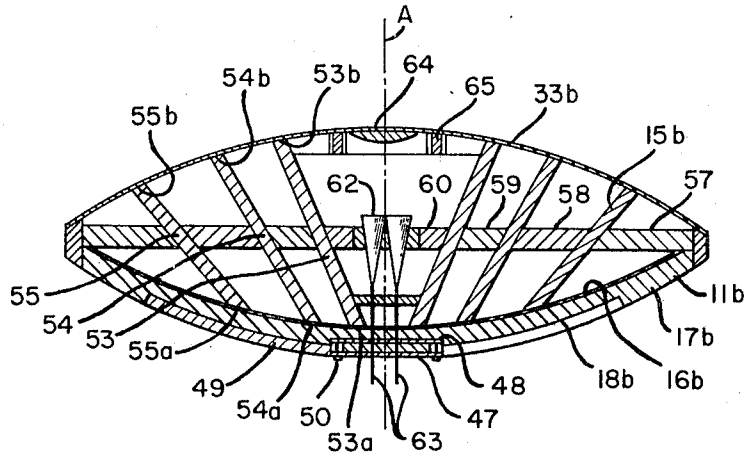

FIG-9

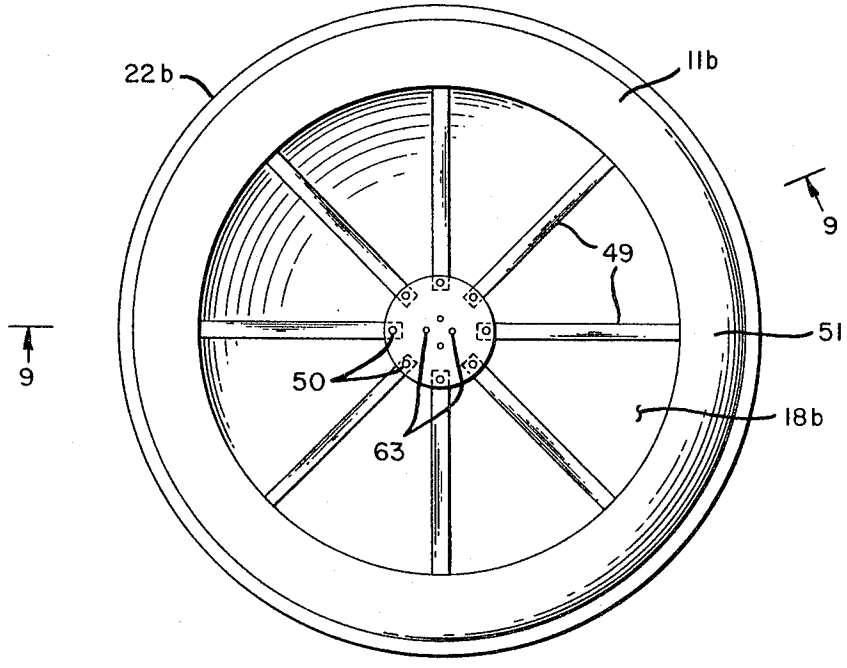

FIG 8

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METHOD OF MAKING DIELECTRIC FOAM ANTENNA

Original Filed May 31, 1962 6 Sheets-Sheet 4

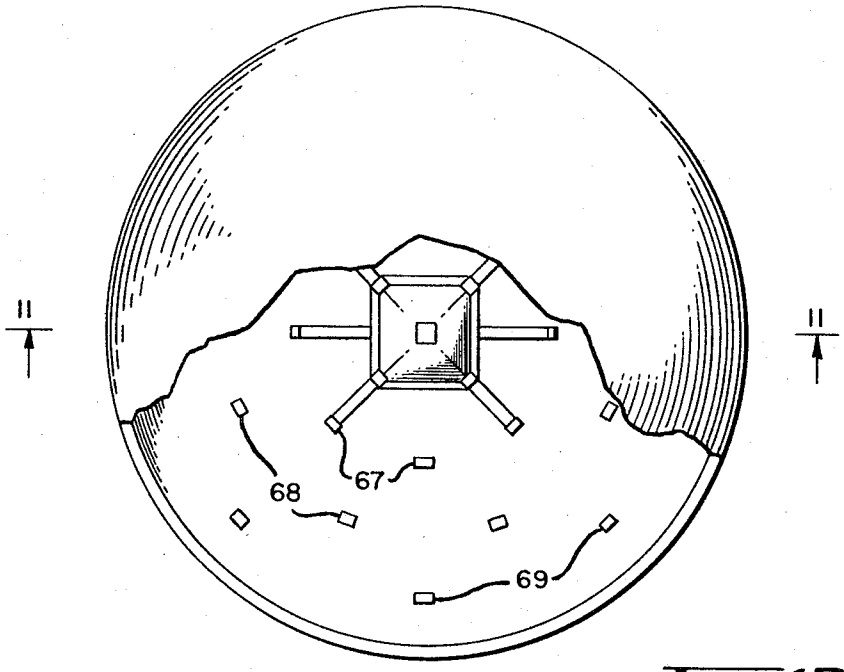

FIG-10

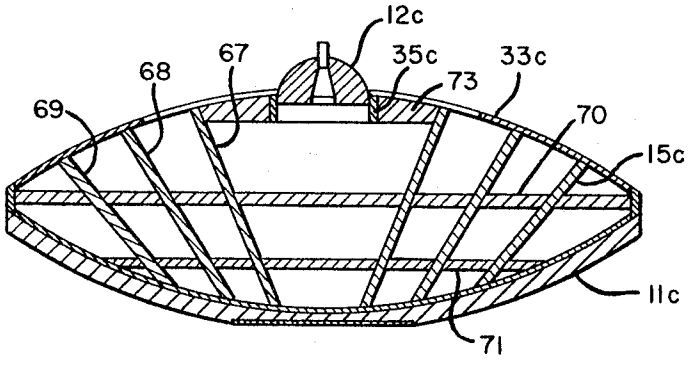

FIG-11

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METHOD OF MAKING DIELECTRIC FOAM ANTENNA

Original Filed May 31, 1962 6 Sheets-Sheet 5

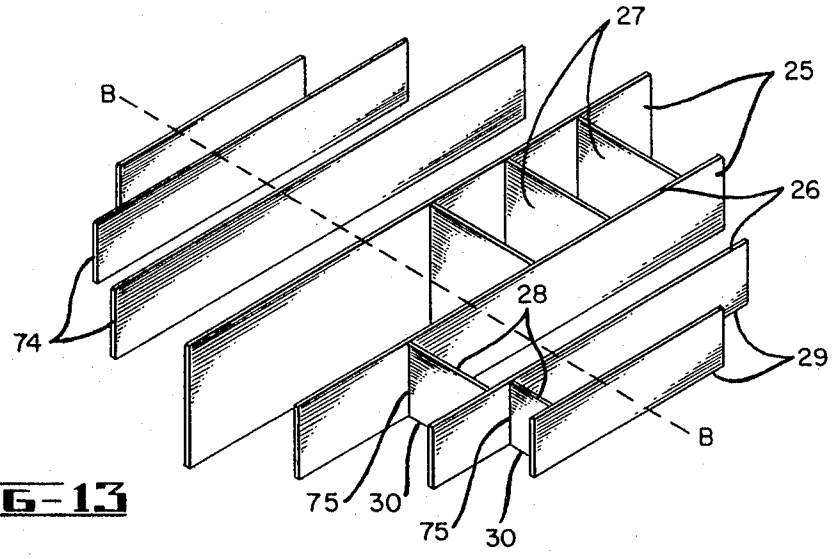

FIG-13

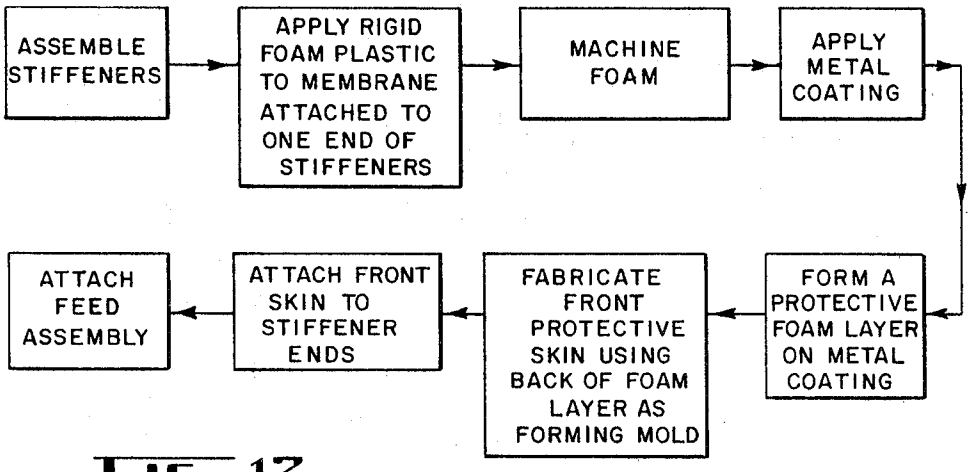

FIG-12

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Jan. 10, 1967 M. SULITEANU 3,296,685

METHOD OF MAKING DIELECTRIC FOAM ANTENNA

Original Filed May 31, 1962 6 Sheets-Sheet 6

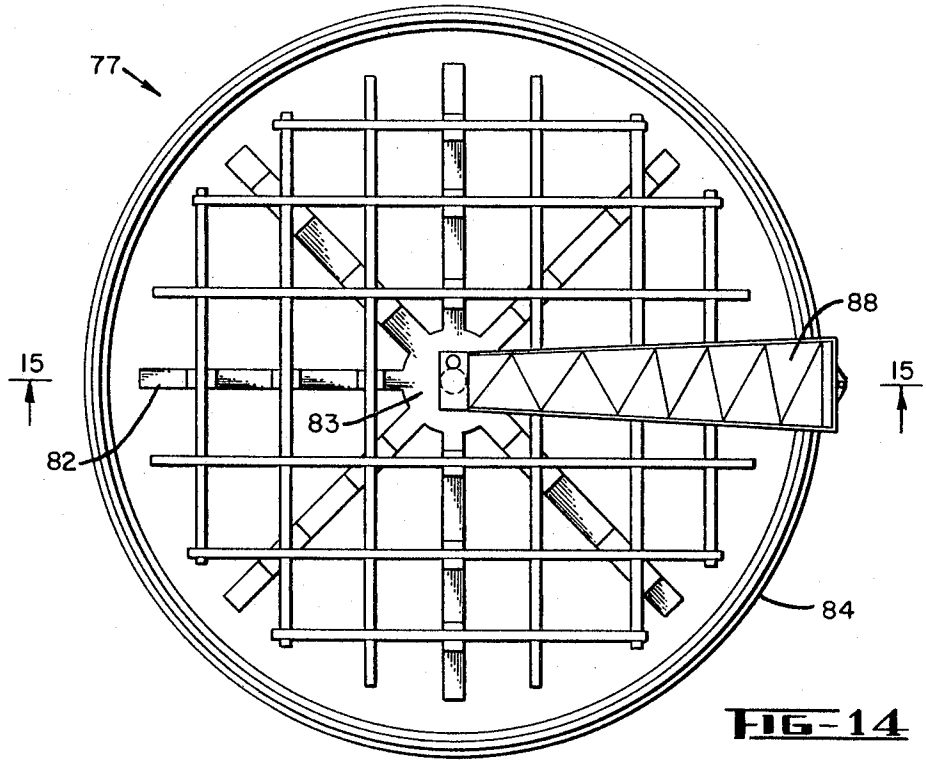

FIG-14

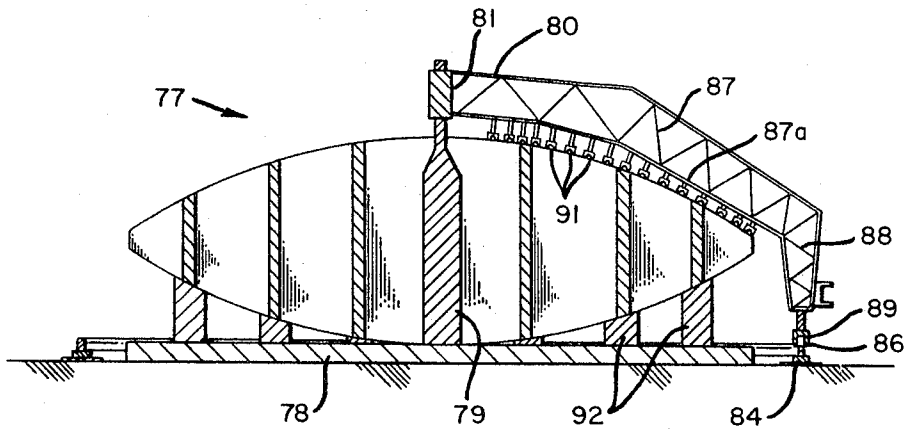

FIG-15

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United States Patent Office 3,296,685 Patented Jan. 10, 1967

3,296,685
METHOD OF MAKING DIELECTRIC FOAM ANTENNA

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Original application May 31, 1962, Ser. No. 199,121, now Patent No. 3,167,776, dated Jan. 26, 1965. Divided and this application Sept. 28, 1964, Ser. No. 399,631
6 Claims. (Cl. 29—155.5)

This is a division of Serial Number 199,121, filed May 31, 1962, now Patent No. 3,167,776. This invention relates to antennas and in particular to large diameter parabolic reflectors of such antennas having structural members composed of plastic and fibrous materials.

It is well known that the gain of an antenna system can be increased using large parabolic reflectors to concentrate an electromagnetic signal in the same manner that a parabolic searchlight reflector provides a sharply defined beam of light. The gain of an antenna is defined as the ratio of the maximum radiant intensity in a given direction to that of a reference antenna with the same power input. However, such reflectors are difficult and costly to manfacture because of their bulkiness and massiveness and also because of the accuracy to which their reflecting surfaces must be machined in order to maximize antenna performance. As the size and weight of the reflector increase, the manufacturing process is further complicated by the fact that the reflector must often be fabricated "piecemeal," usually by quadrants, in order that normal transport facilities may be used to move the reflector between manufacturing and antenna sites. Also, the reflecting surface of the assembled reflector is vulnerable to damage in transit or during assembly in the field. In addition, the mass required to rigidize such reflectors limits scanning rates because of the tremendous accelerating and decelerating forces involved.

General objects of this invention are the provision of a lightweight reflector which can be fabricated rapidly and at low cost; the provision of a reflector with a streamlined silhouette; the provision of an improved method of making a reflector, and the provision of a parabolic antenna in which reinforcing dielectric material is used to both rigidize the reflector and to positively support the feed horn on the reflector.

The objects of the invention are accomplished by the provision of a lightweight parabolic reflector assembly composed almost entirely of lightweight, low-density (2 to 4 pounds per cubic foot) foamed plastic materials. The reflector assembly includes stiffener members located in the mouth of the reflector and extending outwardly from the convex reflector surface parallel to the focal axis. These members serve both to increase the rigidity of the reflector body and to support the antenna feed assembly. The stiffener members do not seriously degrade the electrical performance of the antenna system.

For a better understanding of the invention and other of its objects, refer to the following specification in conjunction with the accompanying drawings in which:

FIGURE 1 is a plan or front view, partially cut-away, of an antenna embodying the invention;

FIGURE 2 is a transverse section taken along line 2—2 of FIGURE 1;

FIGURE 3 is an enlarged view of a portion of the reflector assembly of FIGURE 2;

FIGURE 4 is a front view of a parabolic antenna with a modified type of stiffener members;

FIGURE 5 is a transverse section taken on line 5—5 of FIGURE 4;

FIGURES 6 and 7 are enlarged views of portions of FIGURE 5;

FIGURE 8 is a rear view of another antenna having modified stiffener members in the form of truncated cones;

FIGURE 9 is a transverse section taken on line 9—9 of FIGURE 8;

FIGURE 10 is a front view of another antenna with stiffener members in the form of struts;

FIGURE 11 is a transverse section taken on line 11—11 of FIGURE 10;

FIGURE 12 is a block diagram showing the steps and the order of processing a foam antenna;

FIGURE 13 is a perspective view of elements being formed into stiffener members;

FIGURE 14 is a plan view of a cantilever-type foam cutting machine in operating position over the front of an antenna; and

FIGURE 15 is a transverse section taken on line 15—15 of FIGURE 14.

An antenna system embodying the invention includes a reflector, a feed assembly and a support assembly and is used to transmit electromagnetic waves into space when used in conjunction with a transmitter or may be employed in a reciprocal fashion for use with a receiver. In such applications, energy emanates from or is directed towards a centrally located feed assembly by means of a precisely formed reflector. In the description which follows, such reflectors are referred to as parabolic figures of revolution, but let it be understood that this term is intended to include reflectors which are segments of paraboloids or of the parabolic family typified by the following non-inclusive listing: parabolic cylindrical reflectors, truncated paraboloidal reflectors, and offset paraboloidal reflectors (orange-peel paraboloids).

FIRST EMBODIMENT (FIGURES 1–3)

In FIGURES 1 and 2, the invention is illustrated as an antenna **10** comprising a parabolic reflector **11** having an axis of symmetry A (hereinafter referred to as the focal axis), a feed horn **12** located at the focal point **13** opposite the antenna aperture **14**, and stiffener assembly **15** located between reflector **11** and feed horn **12**.

Reflector **11** is a composite structure having base **17**, an inner layer **18**, and a metallic reflecting skin **16** (FIGURE 3) between the base and inner layer. This reflector is formed so that skin **16** is parabolically shaped and has a focal point **13** located on axis A. Skin **16** may be metal foil film or wire mesh. Base **17** is a load bearing member of sufficient thickness for this purpose and optionally provided with reinforcing rods **19** for additional strength and rigidity. A circumferentially extending flange **22** on the front edge of base **17** additionally strengthens the structure. Mounting plate **24** mechanically secures the reflector to a support pedestal (not shown) and is located symmetrically about axis A and is firmly attached to the backside of base **17**. The support pedestal is omitted from the drawing in the interest of clarity.

The main body of base **17** and inner layer **18** are formed of a commercially available, low-density lightweight polyurethane plastic foam material sold under the trademarks Polycel Urethane or Lockfoam. Such foam material is characterized by an abundance of voids (entrapped air) and may be formed by mixing a polyether, epoxy or other resin with an organic isocyanate such as tolylene diisocyanate. The resultant cellular structure has a low density (2 to 4 pounds per cubic foot), and does not substantially adversely affect electromagnetic waves passing through it.

In the form of the antenna shown in FIGURES 1

and 2, the stiffener assembly **15** resembles an egg crate and comprises a plurality of plane sheets **25** of dielectric foam material which extend parallel to each other in a first direction across the reflector and which are spaced apart in a second direction transversely of the first direction. The sheets **25** extend out from the reflector parallel to the focal axis and each is permanently secured along its inner edge **26** to the inner layer **18** of the reflector, see FIGURE 1.

Spacers **27** similar to sheets **25** extend between and normal to the sheets in parallel rows extending in the second direction and each spacer **27** is permanently secured along its inner edge **28** to the inner layer **18** of the reflector and to the sheets **25** it abuts. The outer edges **29** of the sheets and outer edges **30** of the spacers preferably are convexly curved so that these edges of all the sheets and spacers lie in an imaginary curved surface.

A thin skin or cover **33**, preferably made of polyurethane foam reinforced between fibrous-glass cloth, as explained hereinafter, is secured to the outer edges **29** and **30** of the sheets and spacers, respectively, and to flange **22** to enclose the front of the antenna. Sheets **25** and spacers **27** preferably are formed from expanded polystyrene foam sold under the trademark Styrofoam and having low density and exceptional perviousness to microwaves. Styrofoam, for example, having a density of 2 pounds per cubic foot has a loss tangent of 0.0002 and a dielectric constant of 1.05.

Feed horn **12**, shown as a pyramidal horn, is supported symmetrically of the focal axis at focal point **13** by a dielectric housing **35** secured to the outer central parts of the sheets and spacers closest to the focal axis. The horn axis is coincident with the focal axis so that electromagnetic waves emanating from the horn uniformly illuminate the reflector. The housing **35** firmly supports the horn on the stiffener assembly so that the position of the horn relative to the reflector is fixed.

The use of polystyrene and/or polyurethane rigid foam plastic material for the antenna structure greatly reduces weight without loss of mechanical stability and rigidity. While the structural strength of dielectric foam is substantially less than that of steel or aluminum on the classical pound per square inch basis, a foam antenna constructed in accordance with the invention is extraordinarily rigid and is capable of supporting itself even in relatively large structures. For purposes of comparison, a reflector having a diameter of 18 feet and composed of dielectric foam having an average density of 4 pounds per cubic foot has been fabricated and weighs 530 pounds. A conventional aluminum reflector having the same configuration would weight approximately 2000 pounds. In addition, dielectric foam is practically unresponsive to temperature changes due to its low thermal conductivity, and it is readily cut and easily formed.

SECOND EMBODIMENT (FIGURES 4–7)

The stiffener assembly in the antenna of FIGURES 1 and 2 is assembled and formed relatively easily but it may introduce a slight phase error in waves that travel through the full depth of the sheets **25** and spacers **27** parallel to the focal axis A. In order to minimize this phase error, the antenna shown in FIGURES 4 and 5 is provided with a modified stiffener assembly **15***a* arranged so that the effective length of travel of electromagnetic waves in the dielectric foam is greatly reduced. Stiffener assembly **15***a* is made up of a first series of flat dielectric foam sheets **38** arranged in parallel planes P_1 which are inclined relative to the focal axis A, and a second series of such sheets **39** disposed in parallel planes P_2 which intersect the planes of sheets **38** at right angles. The sheets **38** and **39** extend in one direction, vertically as viewed in FIGURE 4, across the reflector **11***a* and are permanently secured to the reflector as explained later in the description of the method of assembly.

Each junction of sheets **38** and **39** is formed with an elongated bar **42**, see FIGURE 7, extending the length of the sheets. Bar **42** preferably has a rectangular cross-section and the junction edges **40** and **41** of the sheets have V-shaped recesses which fit over the corners of the bar, as shown. A suitable adhesive is used to make the junction permanent.

Sheets **38** and **39** may have a laminated construction as shown in FIGURES 6 and 7 in order to increase their strength and to decrease their weight. The body **43** of each laminated sheet preferably is an extremely lightweight dielectric foam and is reinforced by thinner outer layers **44** and **45**, such as fibrous-glass cloth, having high mechanical strength.

In other respects, the antenna shown in FIGURES 4 and 5 is substantially the same as the antenna of FIGURES 1 and 2, and like or corresponding parts are identified by like reference numbers followed by the suffix *a*.

THIRD EMBODIMENT (FIGURES 8–9)

A third embodiment of the invention shown in FIGURES 8 and 9 is particularly well adapted for parabolic antennas having aperture diameters of 75 feet or greater. Reflector **11***b* comprises base **17***b* having axially spaced metallic hub plates **47** and **48**, preferably made of aluminum, secured to the central rear portion of the base concentrically of the focal axis A. Plates **47** and **48** serve to anchor the reflector to a pedestal, not shown. A plurality of dielectric arms **49** are secured to the hub plates by bolts **50** and extend radially therefrom and slightly forwardly to connection with an annular reinforced dielectric backing flange **51** at the peripheral portion of the reflector. Flange **51** abuts and is secured to circumferential flange **22***b*. The arms **49** and flange **51** follow a generally parabolic contour and rigidly support the metallic reflecting skin **16***b* and inner dielectric layer **18***b*. Arms **59** and flange **51** preferably are laminated polyurethane foam and are reinforced with resin-impregnated fibrous-glass cloth as described previously.

The stiffener assembly **15***b* comprises continuous dielectric foam support members **53**, **54** and **55** formed into forwardly opening truncated cones of progressively increasing diameters arranged coaxially about the focal axis A. The inner edges **53***a*, **54***a* and **55***a* of these members abut and are cemented to the inner surface of the reflector and their outer edges **53***b*, **54***b* and **55***b* are formed to support a concavely-shaped dielectric cover **33***b*. The conical members **53**, **54** and **55** are spaced apart by and are laterally braced against peripheral flange **22***b* through annular spacers **57**, **58**, **59** and **60**, the latter also serving to support a feed horn **62** described below. These spacers are cut from dielectric foam sheets in either monolayer or laminar form, and preferably lie in the plane of the antenna aperture approximately midway between reflector **11** and cover **33***b*.

In order to illuminate the reflector, feed horn **62** is supported coaxially of the reflector on center spacer **60** with its aperture facing outwardly from the reflector. The horn is connected to transmission lines **63** extending through plates **47** and **48** to a microwave energy source, not shown. A secondary convex reflector **64** axially spaced from the horn is illuminated by it and redirects the microwaves toward reflector **11***b* in such a manner that the microwaves are again reflected outwardly in a plane wavefront. Secondary reflector **64** is suitably supported by a dielectric foam frame **65** on the outer portion of center conical member **53**. This type of feed system is used in Cassegranian antennas described in "Antenna Engineering Handbook," Henry Jasik, McGraw-Hill, 1961, Chapter 25, pages 11–14, and is particularly useful and advantageous with large diameter antennas having large focal lengths as an alternative to supporting the feed horn at the focal point.

The divergent shape of conical stiffener members **53**, **54** and **55** minimizes phase error in microwaves passing through them, and additionally insures rigidity of the

entire structure by directing wind loading forces toward central support plates 47 and 48 and the pedestal which supports the reflector.

FOURTH EMBODIMENT (FIGURES 10–11)

FIGURES 10 and 11 illustrate another embodiment of the invention which has less dielectric foam material in the stiffener assembly 15*c*. In other respects the antenna shown in FIGURES 10 and 11 is similar to the antenna of FIGURES 1 and 2 and like or similar parts are designated by like reference numbers combined with the suffix *c*.

Stiffener assembly 15*c* is a modification of stiffener assembly 15*b* shown in FIGURES 8 and 9 in that the truncated conical members 53, 54 and 55 are replaced by three annular series of divergent struts 67, 68 and 69 which are essentially slant height elements of truncated cones. The struts are secured in place by axially spaced dielectric plates 70 and 71, see FIGURE 11, which extend across the face of the reflector and are secured thereto along their peripheral edges. The struts extend through and are secured in preformed openings in plates 70 and 71, and the opposite ends of each strut abut reflector 11*c* and the dielectric cover 33*c*, respectively. Feed horn 12*c* is secured in a suitable dielectric housing or frame 35*c* supported by a frame 73.

The reduced mass of the stiffener assembly 15*c* through use of struts 67, 68 and 69 not only decrease the weight, but also simplifies fabrication and assembly of the antenna.

Method

The method of making the antenna shown in FIGURES 1 and 2 will now be described with reference to FIGURES 12 through 15. Referring to the flow diagram of FIGURE 12, the principal fabrication and assembly steps and the order of their performance are:

(1) Assembling preformed stiffener components into a rigid double convex structure so that the adjacent edges at one end lie in an imaginary approximately paraboloidal convex surface, and the end edges at the opposite end lie in an imaginary generally convex surface;

(2) Applying a layer of polyurethane foam materal to the convex surface formed by a plastic covering placed over the assembly to a substantially uniform depth;

(3) Accurately machining the convex surface of the foam layer to form a precisely accurate parabolic surface which has the desired focal length;

(4) Applying a metallic film to the machined surface of the foam;

(5) Forming a protective foam layer on the convex surface of the metallic film;

(6) Fabricating a laminated cover or skin using the back surface of the reflector as a forming mold;

(7) Attaching the formed front cover to exposed stiffener ends;

(8) And attaching a feed assembly on the focal axis of the assembly.

Each of these steps will now be discussed in greater detail.

Step 1

The formation of stiffener assembly 15 shown in FIGURES 1 and 2 illustrates the first step of the process. Sheet members 25 are sawed to proper lengths from rigid polystyrene foam boards of differing widths. The lengths to which these sheets are cut correspond to the lengths of parallel laterally spaced chords of the circular antenna aperture.

After preforming, the sheets 25 are arranged in parallel laterally spaced relation symmetrically about transverse axis B and with the longitudinal edges 26 and 29 lying in imaginary convex surfaces and with end edges 74 lying in an imaginary cylindrical surface. Spacer members 27, typically shown in FIGURE 13, are next cut to proper lengths from rigid foam boards of varying widths and inserted betwen and normal to adjacent sheet members. The members 27 are aligned in parallel rows spaced apart transversely of axis B and have ends 28 and 30 lying in an imaginary convex surface. Opposite ends 75 are permanently bonded to the sheets with urethane foam as the adhesive. The sheet and spacer members form a rigid unitary structure having external dimensions approximating those of the completed antenna.

The stiffener assemblies 15*a*, 15*b* and 15*c* shown in FIGURES 5, 9 and 11, respectively, are also assembled from pre-cut and preformed dielectric foam components to form a rigid frame-like structure having the same external contours and dimensions. In assembly 15*a* of FIGURE 5 sheets 38 and 39 are cut to proper size, are V-notched on their longitudinal edges and are cemented to transverse junction bars 42. In assembly 15*b* in FIGURE 9, each truncated cone is formed using a preformed mold of the proper dimensions. Thereafter the outer cone having the largest diameter is cemented to spacers 58 and 59, and the inner cone is cemented to spacers 59 and 60. In assembly 15*c* of FIGURE 11, plates 70 and 71 of predetermined diameters are formed with appropriately inclined strut openings, and are axially spaced and approximately anguuarly oriented relative to each other. Struts 67, 68 and 69, cut to proper length, are then cemented in the plate openings and the assembly is complete.

Edges 26 and 28 of sheet and spacer members 25 and 27, respectively, are next machined to form a convex figure of revolution by a shaping machine 77 shown in FIGURES 14 and 15. This machine 77 comprises a horizontal base 78, a vertical pivot shaft 79, and a cutter arm 80 pivotally connected at its end 81 to the top of shaft 79. The base 78 is in the form of a spider having arms 82, see FIGURE 14, removably connected at their inner ends to and extending radially from center plate 83 and terminated adjacent to circular ring 84. The vertical axis C of shaft 79 is coincident with the axis of ring 84.

Arm 80 has a central portion 87 which extends radially and slightly downwardly from shaft 79 with a concavely-shaped undersurface 87*a*, and a vertical outer end portion 88 supported on and movable relative to ring 84. The lower end of outer arm portion 88 has motor-driven rollers attached to housing 86 for engagement with the ring. A plurality of individually rotatable cutters 91 are attached to the underside 87*a* of central arm portion 87 and are individually adjustable.

With cutter arm 80 dismounted from the shaft, the preformed stiffener assembly 15 is placed on foam blocks 92 on the base 78 concentrically of shaft 93. Arm 80 is then mounted on the shaft and ring 84. Cutters 91 driven by suitable motors are individually rotated while arm 80 is rotated by its rollers 89 about shaft 79. In this manner the upper ends (as viewed in FIGURE 15), of the sheet and spacer members comprising the stiffener assembly are accurately machined to lie in a paraboloidal surface.

Step 2

Polyurethane foam is next applied to a thin plastic membrane stretched over the machined ends of the sheet. Preferably the foam in a fluid state is blown by air under pressure onto the surface of the membrane to a depth of approximately 2 to 4 inches. The applied foam dries and hardens in approximately 15 minutes and is ready to be machined in approximately 8 hours. Note that the membrane and hardened foam comprise layer 18 of the reflector, see FIGURE 3.

Step 3

The outer unfinished surface of the layer 18 is then accurately formed to a true paraboloid by cutters 91. This finished surface provides the base for the reflecting layer and therefore must be precisely formed.

Step 4

The metallic reflecting skin **16** is applied to the machined surface of layer **18** by conventional metal spraying techniques. Alternatively, a metallic foil or screen may be used.

Step 5

To the convex surface of reflecting film **16** there is next applied a second or base layer **17** of foam to enclose and protect the metallic skin and to provide a structural body of sufficient strength to permit attachment to the suporting pedestal. This base is therefore thicker than layer **18** and is machined on its outer surface to give the reflector a uniform profile. During the forming of the base layer, additional support means are located within or adjacent to this layer. For example, in the embodiment shown in FIGURE 2, a flange **22** is located at the periphery of layers **17** and **18**, and a series of solid metal rods **19** radially located between the flange and axis are buried within the layer to add rigidity to the reflector. In addition, a fibrous-glass skin is cemented to the outer surface of the base to additionally reinforce and strengthen the structure.

Step 6

Front sandwich skin or cover **33** is next fabricated using the machined surface of the base layer **17** as a forming mold. To the convexed machined surface there is applied a releasing agent to allow the skin to be removed when completed, followed by a fibrous-glass cloth impregnated with a resin. Polyurethane foam layer is next applied to the cloth to a thickness which is less than that of layer **17** and the convex surface is machined to a streamlined silhouette. The assembly is covered with an additional fibrous-glass cloth and the completed skin removed from the reflector. A metal plate **24** is then cemented to the exposed convex surface of layer **17** to provide means for attaching the reflector to a vertical support pedestal (not shown) after which the reflector is removed from the shaping machine, inverted and relocated thereon so that the unattached ends of the stiffeners are directed upwards when viewed in FIGURE 15. Other forms of support equivalent to plate **24** are considered to be within the scope of this invention. For example, a series of radially extending arms **49** shown in FIGURE 8 may also be added to add rigidity to the reflector. These arms attach to the concave surface of layer **18***b* and have ends in contact with annulus **51** located at the periphery of the dish and with central hub plates **47** and **48**.

Step 7

Edges **29** and **30** of the stiffeners are next machined to an accurate parabolic form having a focal length equal to that of the outer surface of layer **17**. The front skin of similar form is then attached to the stiffener edges using a suitable adhesive, such as epoxy resin. Note that machining of the ends of the stiffener is unnecessary when using the stiffener assembly of FIGURES 10 and 11. For this construction, openings rectangular in cross section, are cut in the front skin which allow the struts to protrude through the skin when the latter is attached to circumferentially extending flange **22**. These extensions are sawed off flush with the surface of the cover and additional foam is applied to rigidly fix the struts in place.

Step 8

After the fibrous-glass skin is attached, a round opening is made in the skin at the point where the cover intercepts axis A of the assembly. A polystyrene foam housing or truncated conical shell **35** having a square or round base with dimensions the same as the opening, is then attached to the exposed outer end edges of the central sheet and spacer members. Horn **12** is attached to the housing **35** so that it is rigidly connected and fixed relative to the reflector, the foam shaping machine being utilized to locate the focal axis and focal plane of the structure. The horn **12** is connected by a coaxial line to a transmitter or receiver, not shown.

In some antennas the electrical and mechanical requirements dictate that a Cassegranian feed system be used in order to decrease the width of the antenna as explained above. As shown in FIGURES 8 and 9, such a feed system is assembled by first locating feed horn **62** adjacent to the antenna aperture and then attaching subreflector **64** on the axis A as shown. Feed horn **62** is secured by spacer member **60** while subreflector **64** is rigidly located by means of frame **65** on cone **53**.

It should be understood that this invention in its broadest aspects is not limited to the specific embodiments or methods described above. For example, the stiffener assemblies **15**–**15***c* of the embodiments listed above may be formed into arcuate cylindrical segments in which the imaginary concave surface formed by the ends of the stiffeners are used to form and support layers **17** through **19** of the reflector. An additional foam layer is attached to the imaginary convex surface of the unattached stiffener ends to ruggedize the assembly and form a mold for fabricating cover **33** as described above. The appended claims are intended to include all changes and modifications within the spirit and scope of the invention.

What is claimed is:

1. The method of forming an antenna having a parabolic reflector of a precise focal length consisting of the steps of

assembling stiffener components to form a support structure having first and second end portions defining imaginary convex surfaces,

forming a convexo-concave support element to said first end portion of said structure, said element being composed of plastic foam material,

applying a metallic film to the convex surface of said element,

fabricating a convexo-concave cover member using the convex surface of the metallic film as a forming mold, and

attaching the cover to said second ends of said support structure.

2. The method of forming an antenna system having a parabolic reflector of a precise focal length consisting of the steps of

assembling stiffener components to form a support structure having first and second end portions defining imaginary convex surfaces,

forming a convexo-concave support element to said first end portion of said structure, said element being composed of plastic foam material,

applying a metallic film to the convex surface of said element,

forming a protective foam layer on the convex surface of said metallic film, said foam layer having a convex surface,

fabricating a convexo-concave cover member using the convex surface of the foam layer as a forming mold, and

attaching the formed cover to said second end portions of said structure.

3. The method of forming an antenna system having a parabolic reflector of a precise focal length consisting of the steps of

assembling stiffener components to form a support structure having first and second end portions defining imaginary convex surfaces,

forming a convexo-concave support element to said first end portion of said structure, said element being composed of plastic foam material,

applying a metallic film to the convex surface of said element,

forming a protective foam layer on the convex surface

of said metallic film, said foam layer having a convex surface,

fabricating a convexo-concave cover member using the convex surface of the foam layer as a forming mold,

attaching the formed cover to said second end portions of said structure, and

attaching a feed assembly to said stiffener components along the focal axis of said reflector.

4. The method of forming an antenna system having a parabolic reflector of a precise focal length consisting of the steps of

assembling stiffener components to form a support structure, having first and second end portions, said ends defining imaginary convex surfaces,

attaching a continuous plastic membrane to said first end portion of said structure,

applying plastic foam material to said membrane to form a layer coextensive with said membrane,

machining the convex surface of the foam layer to form a precisely accurate parabolic surface,

applying a metallic film to the machined surface of the foam layer,

fabricating a convexo-concave cover member using the convex surface of the metallic film as a forming mold, and

attaching the formed cover to said second ends of said support structure.

5. The method of forming an antenna system having a parabolic reflector of a precise focal length consisting of the steps of

assembling stiffener components to form a support structure, having first and second end portions, said ends defining imaginary convex surfaces,

attaching a continuous plastic membrane to said first end portion of said structure,

applying plastic foam material to said membrane to form a layer coextensive with said membrane,

machining the convex surface of the foam layer to form a precisely accurate parabolic surface,

applying a metallic film to the machined surface of the foam layer,

forming a protective loam layer on the convex surface of said metallic film, said foam layer having a convex surface,

fabricating a convexo-concave cover member using the convex surface of the foam layer as a forming mold, and

attaching the formed cover to said second ends of said support structure.

6. The method of forming an antenna system having a parabolic reflector of a precise focal length consisting of the steps of

assembling stiffener components to form a support structure, having first and second end portions, said ends defining imaginary convex surfaces,

attaching a continuous plastic membrane to said first end portion of said structure,

applying plastic foam material to said membrane to form a layer coextensive with said membrane,

accurately machining the convex surface of the foam layer to form a precisely accurate parabolic surface of said focal length,

applying a metallic film to the machined surface of the foam layer,

forming a protective foam layer on the convex surface of said metallic film, said foam layer having a convex surface,

fabricating a convexo-concave cover member using the convex surface of the foam layer as a forming mold,

attaching the formed cover to said second ends of said support structure, and

attaching a feed assembly to said stiffener components along the focal axis of said reflector.

No references cited.

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