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3,296,617

TARGET KITE

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2 Sheets-Sheet 1

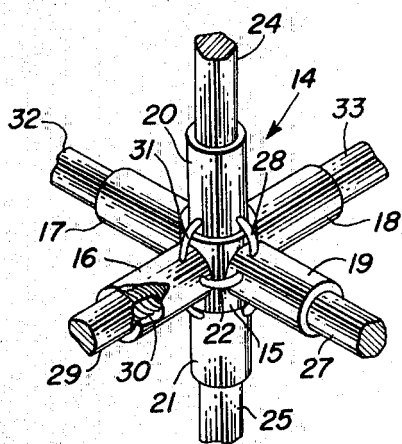
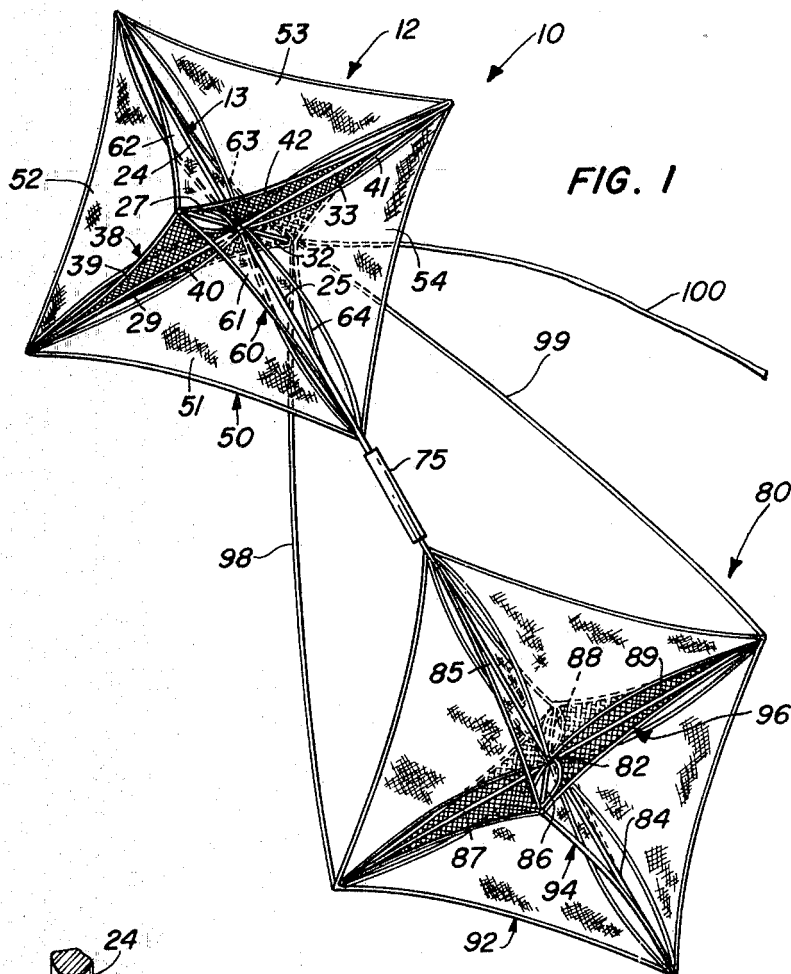


FIG. 2

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2 Sheets-Sheet 2

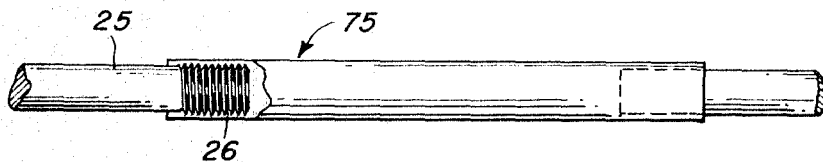


FIG. 3

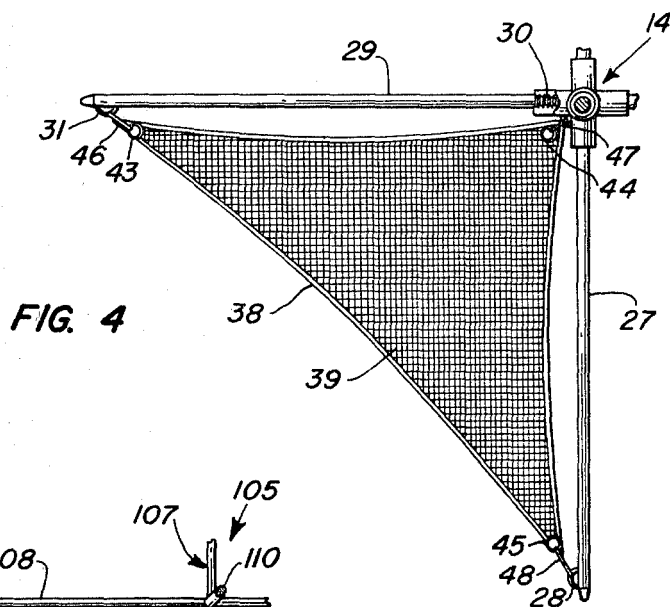


FIG. 4

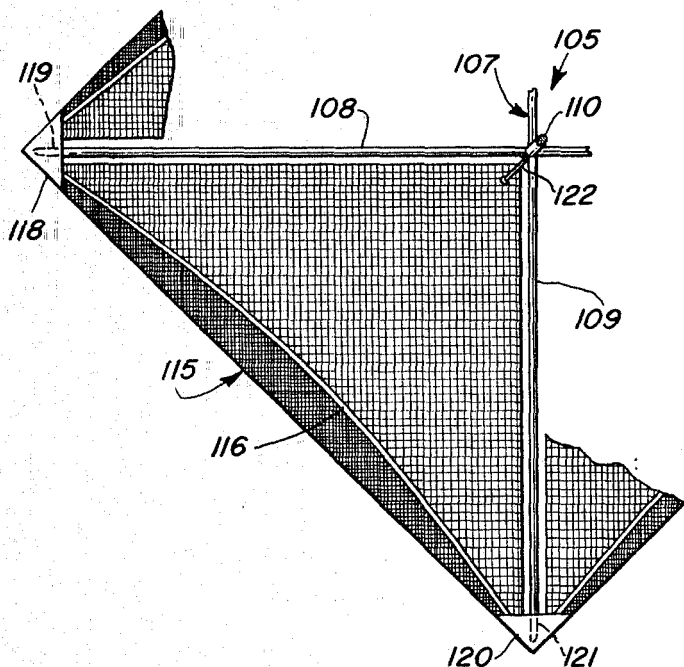


FIG. 5

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TARGET KITE

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The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

This invention relates to a kite, and more particularly to a kite which is a self-supporting, airborne, electromagnetic wave corner reflector.

A need has long existed for an airborne reflector which is of simple design, collapsible to facilitate transportation, and operable without auxiliary lifting means. Various prior art arrangements have been suggested, but to date a radar reflector which is self-sustaining has not been developed. Prior art radar reflectors include corner reflectors which have electromagnetic wave reflecting properties; however, these corner reflectors are required to be carried or towed by an auxiliary power source such as an airplane. The many disadvantages adherent in this arrangement are obvious, particularly as a transportable piece of equipment. A man downed at sea or in the field usually does not have at his disposal propulsion means whereby he can loft a corner reflector which must be towed or carried.

It has been proposed to trail a corner reflector behind a conventional kite. This is operational to a degree; however, this has been found to be highly detrimental to flight, due to the weight and drag characteristics of the corner reflector. The flight, weight, and drag characteristics of an aircraft are also adversely affected when towing a corner reflector.

An ordinary kite configuration having reflective properties has also been proposed; however, is inferior to a kite having a corner reflector configuration due to its unitary planar surface.

Corner reflectors may be lofted by rigid support structure, but the height to which the corner reflector may be positioned is limited. This is readily apparent if the device is to have any kind of a portable concept, and is true even if the corner reflector is to be stationary since a rigid tower of any height is normally out of the question and limited in nature. Since radar operates on a line-of-sight principle, the higher the corner reflector, the greater its effective range.

The invention here under consideration overcomes the many difficulties of the prior art enumerated above. Since the kite of this invention has the general configuration of a corner reflector, it has the electromagnetic wave reflecting characteristics of a corner reflector. In view of the fact that the corner reflector is a kite, it is self-supporting in nature eliminating the necessity for auxiliary lifting mechanism. The kite is collapsible and therefore portable to an extent necessary to meet practically any field situation. It is portable not only in the sense of being compact, but is also lightweight. Since a kite is a flying object, it is capable of obtaining altitudes of many feet. Obviously, the effective range of the corner reflector is increased many miles by the capability of positioning it at such an altitude. It is also recognized that the corner reflector and kite being one and the same, superior aerodynamic properties are obtained over the arrangement whereby a conventional kite is utilized to drag or tow a corner reflector.

In view of the above discussion, it is an object of this invention to provide a corner reflector which is a self-sustaining kite.

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A further object of this invention is to provide a self-sustaining corner reflector which is collapsible and, therefore, highly portable.

Yet another object of this invention is to provide a self-sustaining corner reflector which is of a simple design and lightweight construction.

Still another object of this invention is to provide a corner reflector in the form of a kite having superior aerodynamic flight characteristics.

These and other objects and advantages of this invention will become more apparent upon reading the specification in conjunction with the accompanying drawings.

In the drawings:

FIG. 1 is a perspective view of the corner reflector kite as it might appear in flight;

FIG. 2 is a perspective view of a union or coupling utilized to join the struts of the kite framework;

FIG. 3 is a side elevational view of a connector used to join the wing and tail sections of the kite;

FIG. 4 is a segmental, plan view of a wing section quadrant, showing the structure utilized to connect flexible material to the kite frame;

FIG. 5 is a segmental, plan view of an alternate wing section quadrant, showing another arrangement for securing flexible material to the kite frame.

Basically, this invention relates to a kite which is also a corner reflector. The kite has a three-axis frame, the struts thereof being joined intermediate their ends in a mutually perpendicular relationship. Flexible material is secured to the struts in a manner to provide a three-planar configuration intersecting at their geometric centers. Two of the planar surfaces provide lift and stabilization respectively, whereas the third planar surface is made porous to cause as little aerodynamic effect as possible. The flexible material utilized to form the various surfaces have electromagnetic wave reflecting properties necessary for a corner reflector. A single three-planar kite unit has been found operable; however, flight characteristics have been improved by joining two three-planar units along a common axis to form a tandem arrangement. In the tandem arrangement one unit, normally the lead unit, operates as a wing section whereas the other unit operates as a tail section.

Referring now more specifically to the details of the invention, FIG. 1 best illustrates the kite which is designated generally by the reference numeral 10. The kite 10 is of the tandem type having a first unit or wing section 12 and a second unit or tail section 80. These sections are joined together by a connector 75 in a manner which will be explained more fully hereinafter.

The first unit or wing section 12 has a frame 13 which also includes a coupling or union 14. The coupling 14 has a base 15 shown in FIG. 2 as a cylinder. The base 15 may also take the configuration of a cube either configuration being a solid construction to lend rigidity to the framework. Fixed to the coupling base 15 by conventional means such as welding, are a series of posts 16, 17, 18, 19, 20, and 21. The posts 16-19 are positioned at 90-degree intervals about the circumference of the cylindrical coupling 15, and the posts 20 and 21 project from either end of the cylinder. As shown in FIG. 2, this arrangement provides a three-axis structure whose axes are mutually perpendicular. Each of the posts are provided with a threaded receptacle, the post 16 being partially cut away in FIGS. 2 and 4 to reveal the threads. The coupling 15 has a series of tiedown rings 22 connected between the posts. The tiedown rings 22 act as anchors to which the airfoils are connected in a manner which will be explained more fully hereinafter. The coupling and frame is preferably made from a lightweight material such as aluminum or magnesium.

Having threaded engagement with the various posts are the lead strut 24 with the post 20 the center strut 25 with the post 21, the top strut 27 with the post 19, the left strut 29 with the post 16, the bottom strut 32 with the post 17 and the right strut 33 with the post 18. Threads 30 formed on the end of strut 29 are shown engaged with the threaded receptacle of post 16 in FIG. 4 for purposes of illustration. The center strut 25 is threaded at both ends, the threads 26 (FIG. 3) engaging the connector 75 for purposes to become more apparent subsequently. As shown in FIG. 4, the outer extremities of top strut 27 and left strut 29 have fastener rings 28 and 31 respectively. These fastener rings operate as a means for securing the flexible material to the kite frame in a manner now to be described.

A flexible, grid or net like porous cross sheet 38 is fixed to the top post, left post, bottom post, right post, and the union or coupling 14. The sheet 38 is divided into 4 panels 39, 40, 41 and 42. The exposed edges of the panels are slightly scalloped or recessed to provide a more uniform membrane tension and thereby improve their aerodynamic or reflective properties. FIGURE 4 shows in some detail the manner in which the panel 39 is fixed to the top strut 27 and the left strut 29. The panel 39 is generally triangular in shape and has eyelets 43, 44, and 45 secured to each of the respective corners thereof. Snap fasteners 46, 47, and 48 are connected to the eyelets in a conventional manner. The snap 46 connects to the fastener ring 31, the snap 47 to the tie-down ring 22 and the snap 48 to the fastener ring 28. The snaps are of a conventional design and may have a swivel connection with the eyelets to prevent possible fouling of the panels. The three-point connection provides an adequate arrangement for fixing the panel to the kite frame; however, it is to be understood that within the broadest aspect of the invention other connecting arrangements may be utilized. Each of the other panels is fixed to the kite frame 13 in a similar manner; therefore, the particular details of securing each panel to the frame will not be explained again. The cross sheet 38 is constructed from a wire mesh. The wire mesh has electromagnet wave reflecting properties, but due to its porous nature does not adversely affect, to any extent, the aerodynamic properties of the kite. Its porous nature is desirable for the operation of the kite since, as viewed in FIG. 1, the cross sheet 38 is positioned so as to be generally normal to the direction of movement of the kite.

A wing foil or surface 50 is fixed to the lead strut 24, left strut 29, center strut 25 and right strut 33 as shown in FIG. 1. The wing foil 50 has a first panel 51, second panel 52, a third panel 53, and fourth panel 54. Each one of these panels is connected to the kite structure in a manner similar to the panel 39 previously discussed. The wing foil 50 is made from a flexible material having electromagnetic wave reflecting properties, and being of a nonporous nature so as to provide lift for the kite. Although various materials may be utilized for the wing foil, it has been found that a material known as metalized Mylar is ideal for this surface.

A stabilizing airfoil or surface 60 is fixed to the lead strut 24, the top strut 27, the center strut 25, and the bottom strut 32. The stabilizing airfoil 60 like the wing airfoil 50 and cross sheet 38 is divided into panels, the stabilizing airfoil having a first panel 61, second panel 62, third panel 63, and fourth panel 64. These panels also are fixed to the kite frame 13 in a manner similar to that of panel 39.

A connector 75 is utilized to join the first unit or wing section 12 to the tail section or second unit 80 in a tandem arrangement as shown in FIGS. 1 and 3. It is of a tubular design having internal threads adapted to receive the threaded ends of the center strut of the first and second units. The tube is partially cut away in FIG. 3 to show the threaded connection 26 of center strut 25 with the con-

connector 75. The center strut of the second unit has threaded engagement with the connector 75 in a similar manner.

The tail section or the second unit 80 may be essentially identical in design to the wing section or first unit; therefore, only the major components of the second unit will be described.

The tail section 80 has a coupling 82 to which are detachably connected a trailing strut 84, a center strut 85, a top strut 86, a left strut 87, a bottom strut 88, and a right strut 89. The struts 84 and 85 are oppositely disposed on either side of the coupling 82 as are the struts 86 and 88, and 87 and 89, forming a three planar configuration.

A horizontal reflective airfoil 92, which may be formed of four different sections as in the first unit 12, is connected to the trailing strut 84, left strut 87, center strut 85, and right strut 88. A vertical reflective airfoil 94 is connected to the trailing strut 84, top strut 86, center strut 85, and bottom strut 88. The cross or perpendicular reflector 96 is secured to the top strut 86, the left strut 87, the bottom strut 88, and the right strut 89. The vertical reflective airfoil 94 and perpendicular reflective airfoil 96 may be formed of segments or quadrants and be detachably connected as is the horizontal reflective airfoil 92.

Brace lines or wires are fastened to the outer extremity of bottom strut 32 of the first unit, and to the outer extremities of left and right struts 87 and 89 respectively of the second unit. These brace lines or wires function to prevent excess twisting or misalignment between the target kite first and second units. This bracing may also take the form of semirigid members, and under certain conditions may be eliminated or additional bracing added between the struts of the first and second units as the situation demands.

A kite line 100 is fixed to the outer extremity of the bottom strut 32. The kite line 100 is used in the conventional manner to launch the kite, maintain a certain amount of control on the kite, and for retrieving the kite.

A modified form of the invention is shown in FIG. 5, and designated generally by the reference numeral 105. In this form of the invention, the kite frame 107 is made from three resilient struts 108, 109, and 110. These struts are fixed together at a point intermediate their extremities in a mutually perpendicular arrangement to form a three-planar configuration. These resilient struts may be joined at their centers by any conventional manner such as by welding, clamping or binding. Since the struts are by hinging them together at the midpoints the kite for transportation. With this arrangement the necessity for a centralized coupling is eliminated. Another possible arrangement for connecting the resilient struts is by hinging them together at the midpoints thereby providing a means whereby the frame can be collapsed. Telescoping the struts to make the kite portable is also considered to be within the concept of the invention. The hinging concept can be applied to the target kite assembly 10 discussed above.

The airfoils or reflecting sheets in the modified form of the invention illustrates another manner by which they may be fixed to the kite frame. A segment of such material is shown in FIG. 5 and designated by the reference numeral 115. The reflecting sheet 115 has an overall square configuration and is divided into four generally triangular quadrants to facilitate assembly to the kite frame 107. Each corner of the reflective sheet has a reinforced cap, FIG. 5 showing caps 118 and 120. The cap 118 has a receptacle 119 and the cap 120 a receptacle 121. The receptacle 119 receives the one end of resilient strut 108, and the receptacle 121 receives the one of resilient strut 108. The other ends of the resilient struts 108 and 109 engage reinforcement caps (not shown) in a similar manner. From the above description, it can be seen that each of the reflective sheets are fixed to the frame 107 in a similar manner to pro-

vide the corner reflector arrangement. The inner corners of the triangular quadrants are tied to the frame by cords 122, or a snap eyelet arrangement similar to that shown in the target kite assembly 10 may be utilized. The exposed edges of the sheets may have a binding or strap 116 for reinforcement purposes. Obviously, other arrangements may be utilized to secure the reflective material to the kite frame and still be considered within the scope of the invention.

Although the various surfaces of the kite section or sections have been described as being constructed of metalized Mylar or wire mesh, it is to be understood that within the broadest aspect of the invention other materials may be used. For instance, the surfaces in all planes may have a wire mesh for reflecting purposes, and certain of the surfaces have an additional layer of plastic film or other material to provide lift and stabilization. It should also be understood that the kite functions as a two- or three-planar configuration either as a kite or a reflector. Obviously, the kite is not limited to reflecting electromagnetic waves, but may be used to reflect light as well as other wave media. The particular configuration of the material need not be square, but may take other shapes, for instance, the lifting and stabilizing surfaces being in the shape of an arrowhead. Likewise, the frame does not have to be a three-axis arrangement. Rather, the longitudinal member may be surrounded with a picture frame-like structure positioned essentially perpendicular, and the flexible material stretched between it and the longitudinal member to form a three-planar configuration, each unit having this structure.

It should be noted that although the corner reflector kite is designed to be self-sustaining, it is also capable of being towed by an airplane or ship, the same as a glider.

ASSEMBLY AND OPERATION

The target kite assembly 10, as shown in FIG. 1, is assembled unit-by-unit and the units thereafter joined together in tandem. Since the first and second units may be essentially identical in design, the assembly procedure for both units is similar.

A considered advantage of the corner reflector target kite is its ability to be collapsed and easily transported. Therefore, the user of the target kite would normally encounter the kite in the collapsed state. In the collapsed state, the kite consists of four major components or groups of components, the coupling 14, the struts, the reflective material, and the connector 75. Initially, the threaded ends of the struts are engaged with the threaded receptacles of coupling 14, and screwed into position until tight. Since the center strut 25 is threaded at both ends, it should be used as a reference point for connecting the reflective material to the now assembled frame.

The cross sheet 38 which consists of panels 39-42, having a screen-like or porous texture should be fixed to the posts which are perpendicular to the center post 25 and parallel to its cross section. As shown in FIG. 2, these would be the posts 27, 29, 32, and 33. These panels are fixed to the posts by the snaps which engage the fastener rings on the extremities of the struts, and the tiedown rings on the coupling 14. Thereafter, the remaining panels are snapped to the strut fastener rings and to the tiedown rings of the coupling 14, to form a three-planar configuration as shown in FIG. 1.

The second unit is assembled in a similar manner. The center struts of the first and second units are then joined by threaded engagement with the connector 75. The first and second units are aligned such that the vertical and horizontal surfaces of the first and second units are in essentially the same planes, although within the broadest aspect of the invention it is to be understood that the second unit may assume other angular relationships. If brace lines or wires are utilized, they are tied between the horizontal and vertical struts of the respective units as shown in FIG. 1.

The kite line is secured to the outer extremity of the first unit bottom strut.

Since a single unit will fly and operate as a corner reflector, under certain circumstances only one unit is utilized and need be assembled.

The modified form of the target kite 105 is assembled in essentially the same manner; however, differs somewhat since it is structurally different from the target kite 10. The modified embodiment of the resilient frame would normally be assembled by merely releasing the flexible struts which have been bound in some manner to facilitate transportation. Upon release of the flexible strut they will spring into position to form a three-planar configuration. Here again, the center strut should operate as a reference point, and the screen or porous reflective material secured to the posts which are perpendicular to the center strut and parallel to its cross section. The reflective material in this embodiment is secured to the frame by placing the ends of the struts in the receptacle formed within the reinforcement caps such as 118 and 120 as shown in FIG. 5. The inner corners of the triangular quadrants are tied to the frame at the point where the resilient struts intersect. If two units are utilized they are joined together by a connector such as 75 and the first and the second units aligned so that the horizontal and vertical surfaces may be in essentially the same plane. The brace wires or lines are then tied between the units and the kite line secured to the outer extremity of the first unit bottom strut.

If the target kite is a two-unit arrangement, its aerodynamic principles are more like that of a glider or conventional aircraft. The first unit or wing section operates somewhat in the manner of the wings of a glider to provide lift for the kite. The second section operates like the tail section of the glider to provide stability; however, the horizontal surface of the tail section also provides a certain amount of lift. As with the single unit, the porous reflecting surfaces of both the wing and tail sections of the kite have very little or no effect on the kite even though they are essentially perpendicular to the angle of attack of the kite. The airstream merely passes through the porous surface with minimum drag.

The connector 75 which joins the first and second units of the kite may allow the tail section to be set at an angular position with respect to the wing section. In actual flight tests, it has been found that this feature can improve the stability of the kite.

In view of the above description it should now be apparent that this invention provides many advantages over existing arrangements. The target kite here under consideration has superior aerodynamic properties, particularly the tandem arrangement of the kite. The kite is self-supporting eliminating the necessity of some auxiliary means to keep it airborne. The surfaces of the kite perform the dual function of reflecting as well as operating as airfoils to render the kite operative. The kite has superior reflecting qualities since it is made in the configuration of a corner reflector. The kite is of a simple construction, relatively lightweight and can be rapidly assembled or disassembled to make it portable and therefore a versatile piece of equipment. Since the kite is of economical construction, it may also be considered of an expendable nature.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. A corner reflective kite comprising: a three-axis support structure means; nonporous material means fixed to three axes of said support structure means in a manner to form lift and stabilizing surfaces; porous material means fixed to two axes of said support structure to allow passage of air thereby facilitating flight; said porous and nonporous material having reflecting properties.

2. A reflective kite as in claim 1 wherein said three-axis support structure is collapsible.

3. A reflective kite as in claim 1 wherein said porous and nonporous material is flexible.

4. A reflective kite as in claim 1 wherein said nonporous material is metallized Mylar.

5. A reflective kite as in claim 1 wherein said porous material is a metal screen or mesh.

6. A reflective kite comprising: a first three-axis support structure; a second three-axis support structure; means connecting said first and second three-axis support structures along a common axis; nonporous material means fixed to three of the same axes of said first and second three-axis support structure to form lift and stabilizing surfaces; porous material means fixed to two of the same axes of said first and second three-axis support structure to facilitate passage of air and flight of the kite; said porous and nonporous material having electromagnetic wave reflecting properties.

7. A flying corner reflector comprising: a first unit having a mutually perpendicular three-axis support structure, a second unit having a separate mutually perpendicular three-axis support structure, means for joining said first and second units along a common axis; at least one of said units having a lifting airfoil fixed to two of its axes, the other unit having a stabilizing airfoil fixed to two of its axes, and reflective material fixed to each axis of said first and second unit three-axis support structures to form a corner reflector.

8. A flying corner reflector comprising: a wing section; said wing section having support structure; said support structure including a horizontal, vertical, and longitudinal member joined at their center; a nonporous lift surface fixed to said horizontal and said longitudinal members; a nonporous airfoil fixed to said vertical and said longitudinal members; porous material fixed to said horizontal and said vertical members; a tail section, said tail section having support structure including a horizontal, vertical, and longitudinal strut joined at their centers; the end of said longitudinal strut being connected to the end of said longitudinal member; a nonporous stabilizing airfoil fixed to said vertical and said longitudinal struts; a nonporous surface fixed to said horizontal and longitudinal struts; and a porous surface fixed to said horizontal and vertical struts, each of said airfoils and surfaces having electromagnetic wave reflecting properties.

9. A flying corner reflector as in claim 8 wherein the horizontal, vertical, and longitudinal struts and members are joined at their centers by a detachable union.

10. A flying corner reflector as in claim 8 wherein a detachable connector joins said longitudinal member and said longitudinal strut.

11. A flying corner reflector as in claim 9 wherein said porous and nonporous airfoils and surfaces have eyelets;

snaps connected to said eyelets; tiedown rings formed on said union, horizontal, vertical, and longitudinal support members and struts, said snaps fastening to said tiedown rings to fix said porous and nonporous airfoils and surfaces to said wing section and said tail section.

12. A flying corner reflector as in claim 8 wherein said porous surfaces are a flexible wire mesh.

13. A flying corner reflector as in claim 8 wherein said nonporous airfoils and surfaces are a flexible metallized Mylar.

14. A flying corner reflector as in claim 8 wherein cross braces are connected between said wing section and said tail section.

15. A corner reflector comprising: a self-sustaining kite; said kite having surface means with reflecting properties; said surface means being arranged so as to reflect to an object receiving the reflection regardless of the position of said kite.

16. A reflective kite as in claim 15 wherein said kite has at least three intersecting planes; each plane consisting of a sheet of flexible material having electromagnetic reflecting properties, said sheets having pockets, a three-planar frame, said frame engaging said sheet pockets to stretch said sheets over said frame.

17. A reflective kite as in claim 16 wherein reinforcement means is provided between said pockets and the ends of said frame.

18. A reflective kite as in claim 16 wherein said frame is constructed of a resilient material capable of being collapsed and thereafter returning to its three-planar form.

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