

July 2, 1963

R. W. MARTIN
COMPOSITE REFLECTOR FOR TWO INDEPENDENT
ORTHOGONALLY POLARIZED BEAMS

3,096,519

Filed April 14, 1958

2 Sheets-Sheet 1

Fig. 1A.

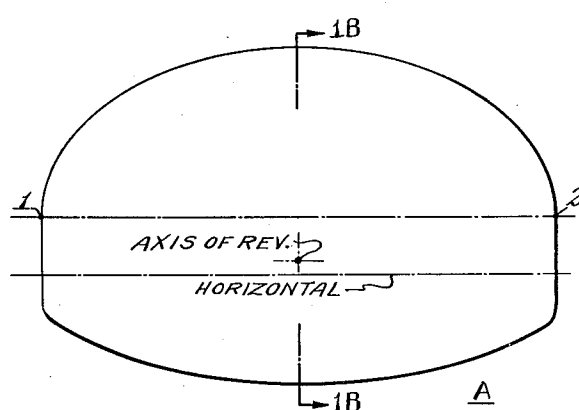


Fig. 1B.

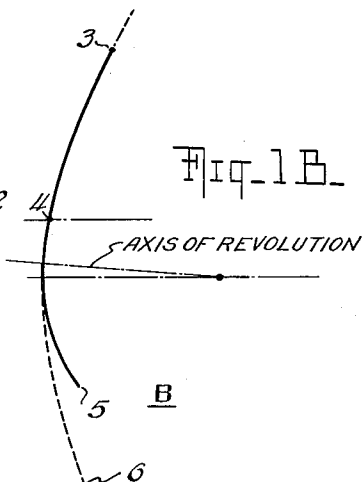


Fig. 2A.

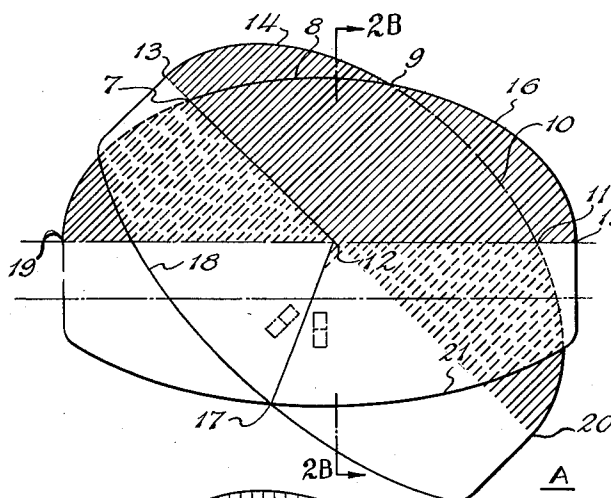


Fig. 2B.

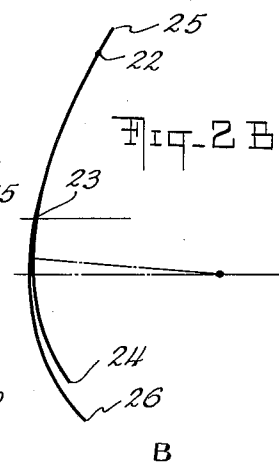
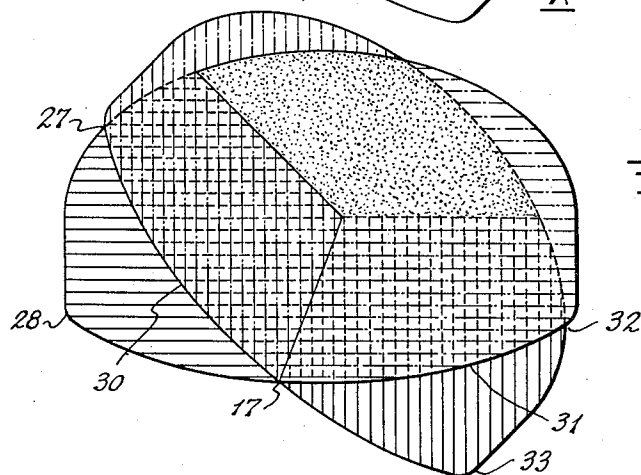


Fig. 3.



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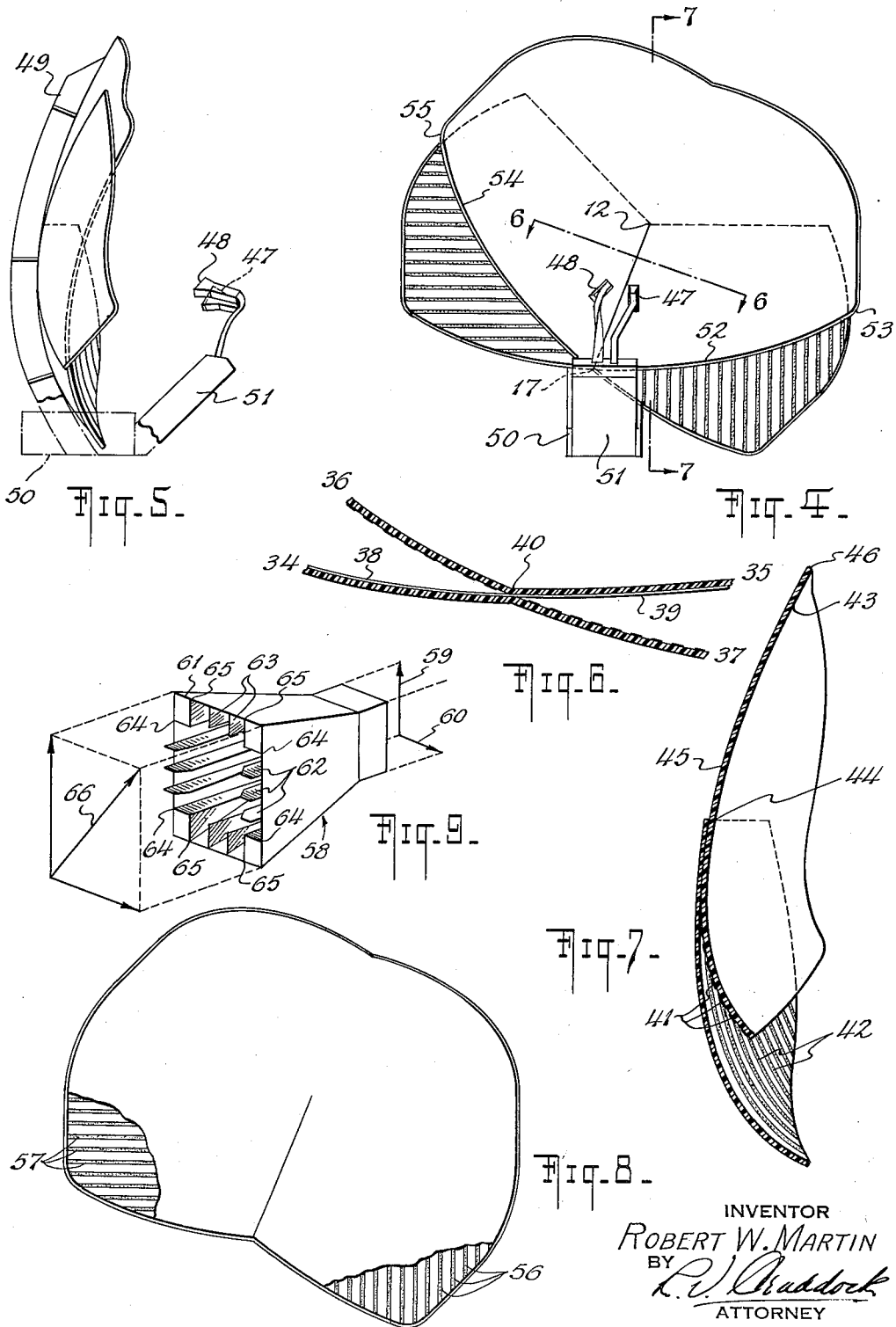
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The invention relates to microwave energy directive devices and, more particularly, is concerned with a composite microwave energy directive element which is adapted to receive two independent beams of orthogonally polarized microwave energy and operative to direct said independent beams along independent paths.

Various applications exist in the art for the transmission of independent beams of microwave energy along respective paths which bear a predetermined angular relationship with respect to each other. One familiar example is the beam configuration generated for use with a V-beam height finding radar. A conventional V-beam radar antenna array is shown in FIG. 13.15(a) appearing on page 482 of the MIT Radiation Laboratory Series, vol. 12, edited by Samuel Silver and entitled "Microwave Antenna Theory and Design." Such an array usually comprises two independent microwave energy reflecting elements each of which is shaped to produce a fan-shaped reflected beam of microwave energy. One of the reflectors produces a fan-shaped beam lying in a vertical plane. The reflector is rotated through a predetermined angle, relative to the first reflector, so as to produce a fan-shaped beam of microwave energy lying in a plane displaced from the plane of the vertical beam by a predetermined angle, for example, 45°.

The two reflectors are arranged on a common supporting pedestal and require at least a two-fold increase in the total structure of either of the reflectors when used alone. Accordingly, the physical size, weight, and profile bulk of the prior art V-beam antenna array impose undesirable handicaps as to ease of assembly and portability, for example, of the antenna installation.

It is the general object of the present invention to provide a microwave energy directive element which reduces to a minimum the physical size, weight, and profile bulk of energy directing means required to produce two independent and spatially displaced beams of microwave energy.

A more specific object of the present invention is to provide a composite microwave energy directive apparatus having a portion common to the component individual microwave energy directive means which function to produce two independent and spatially displaced beams of microwave energy.

Another object of the present invention is to provide a superimposed polarization isolated shaped reflector for producing fan-shaped beams of microwave energy for use in a height-finding radar system.

A further object of the present invention is to provide a composite microwave energy reflective element comprising two electrically isolated component shaped reflectors, each conforming in part to the same surface of revolution.

An additional object is to provide a superimposed microwave energy reflector comprising two independently operative energy directing means each having respective polarization sensitive microwave energy reflecting means.

These and other objects of the present invention, as will appear more fully upon a reading of the following specification, are achieved in a preferred embodiment by the provision of a composite microwave energy reflector which may be considered as being comprised of two identical component microwave energy reflectors, each conforming in part to the same surface of revolution. An understanding of the shape of the composite reflector may

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be facilitated by the following description of the manner in which the composite reflector is generated. The two component reflectors are at first exactly superimposed whereby the respective reflecting surfaces are everywhere in intimate contact. Then, one of the reflectors is rotated through a predetermined angle, relative to the other, about the axis of revolution of the surface of revolution.

In an illustrated preferred embodiment of the invention, each of the component reflectors includes a first portion conformal to the same paraboloid and a second portion which is doubly shaped so as to produce a resultant beam pattern of reflected microwave energy which is narrow in one dimension and approximately cosecant-squared in shape, for example, in a second orthogonal dimension. After the angular displacement of one of the component reflectors relative to the other through an angle of, for example, 45°, there results a composite microwave energy reflector, containing a surface common to the otherwise independent reflectors, which is suitable for application in a V-beam height-finding radar system.

Each of the two reflectors comprising the composite reflector is electrically isolated from the other by the use of polarization sensitive reflecting elements. In the illustrated preferred embodiment, each of the component reflectors consists of a shaped plastic material which is similar to that employed in modern lightweight radomes. The plastic material serves as a mechanical support for polarization sensitive reflecting elements such as, for example, flat metallic microwave energy reflecting strips which are bonded to the plastic material. The strips are arranged parallel to each other in each of the component reflectors, the strips being mounted in a horizontal direction in one and mounted in a vertical direction in the other component reflector.

The composite reflector is irradiated by a pair of microwave energy emitting means each of which emits microwave energy which is polarized orthogonally with respect to the other. As a result, each of the component reflectors comprising the composite reflector "sees" only the respectively associated microwave energy emitting means so that two electrically independent beams of microwave energy are emitted from the composite reflector.

For a more complete understanding of the present invention, reference should be had to the following specification and to the appended drawings of which:

FIG. 1A is a front and FIG. 1B is a sectional view of one of the two identically shaped component reflectors utilized in the composite reflector which conforms to a figure of revolution over a portion of its surface;

FIG. 2A is a front and FIG. 2B is a sectional view of the composite reflector resulting from the rotation through a predetermined angle of one of two identically shaped component reflectors relative to the other about the axis of revolution of the figure of revolution;

FIG. 3 is a front view of the composite reflector which illustrates the location of polarization sensitive reflecting elements associated with the respective component reflectors;

FIG. 4 is a front elevation of the composite reflector; FIG. 5 is a side elevation of the composite reflector of FIG. 4;

FIG. 6 is an enlarged sectional view of the composite reflector of FIG. 4 taken along the line 6—6;

FIG. 7 is an enlarged sectional view of the composite reflector of FIG. 4 taken along line 7—7;

FIG. 8 is a front elevation of the composite reflector of FIG. 4 illustrating the addition of shaped dielectric material to the lower portions of the composite reflectors which serves to equalize the electrical path length between the microwave energy emitting means and the sym-

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metrically located portions of the respectively associated component reflectors; and

FIG. 9 is a schematic diagram of a flared horn useful for irradiating the slanted component reflector.

FIG. 1A illustrates one of the two component microwave energy reflectors which comprise the composite reflector of the present invention. The uppermost portion of the reflector consists of a portion of a figure of revolution which is a paraboloid in the illustrated preferred embodiment. The paraboloidal surface exists above the horizontal line drawn between the numerals 1 and 2. It will be noted that the axis of revolution of the paraboloidal surface is below the line 1—2. The lower portion of the reflector of FIGURES 1A and 1B, i.e., the portion below line 1—2, is a double curvature reflector which acts with the upper paraboloidal portion to produce, for example, a cosecant-squared beam of reflected microwave energy when irradiated. The reflector of FIGURES 1A and 1B is generally similar to the barrel-shaped reflector well known in the art and illustrated in FIG. 13.17 of the aforementioned MIT Radiation Laboratory Series, vol. 12, page 484.

The curvature of the reflector of FIG. 1A is illustrated in the section of FIG. 1B taken along the line 1B—1B. From the section it can be seen that the curvature between points 3 and 4 of the reflector is conformal to a parabola and that the curvature between the points 4 and 5 is somewhat more pronounced than that of a parabola, the latter of which is illustrated by the dotted line between points 4 and 6. The increased lower curvature of the reflector of FIGURES 1A and 1B produces increased high altitude coverage when the reflector is utilized in a ground based height-finding radar system.

In the generation of the composite reflector of an illustrative embodiment of the present invention, two identically shaped reflectors, like the one illustrated in FIGURES 1A and 1B, are first superimposed so that their respective elemental surfaces are everywhere in intimate contact. Then, one of the reflectors is rotated about the axis of revolution of the figure of revolution to which a portion of each reflector conforms. The result of such a rotation is illustrated in the composite reflector of FIGURES 2A and 2B. As previously mentioned, only the uppermost portion of each component antenna of the composite reflector is conformal to a paraboloid. Therefore, upon rotation of one of the component antennas relative to the other, the elemental surfaces of the antennas which first were everywhere in intimate contact depart from each other. This is true because each of the component reflectors is not completely comprised of the common figure of revolution but only partially so. Thus, as the angle increases through which the reflectors are mutually displaced, the extent of the remaining common area decreases.

Assuming, for example, that the displacement angle is 45° (commonly employed in V-beam height-finding antenna arrays), the remaining common surface area of the composite reflector is that embraced within lines 7—8—9, 9—10—11, 11—12 and 12—7. In addition to this area which is common to both component reflectors, there are also two additional and symmetrically identical paraboloidal surface areas embraced within the lines 13—14—9, 9—8—7 and 7—13 and within lines 15—16—9, 9—10—11 and 11—15. Each of these additional surfaces is not shared by both of the component reflectors but is unique to a respective one of the component reflectors. However, it will be noted that the common surface as well as the two additional surfaces just described are all conformal to the same paraboloid.

The remaining portions of the composite reflector of FIGURES 2A and 2B do not lie on one surface as is indicated by the dotted peripheral lines of the rearward portions of the composite reflector. The slanted reflector intersects with the horizontally disposed reflector along the line 12—17. The forward portion of the slanted reflector

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which is outlined by the lines 13—12, 12—17 and 17—18—13 lies above (as viewed in FIG. 2A) the rearward portion of the horizontally disposed reflector which is outlined by the lines 7—12, 12—17 and 17—19—7. The rearward portion of the slanted reflector which is outlined by lines 17—12, 12—11 and 11—20—17 lies below the forward portion of the horizontally positioned reflector which is outlined by lines 17—12, 12—15 and curved line 15—21—17. In other words, the surfaces of the component reflectors comprising the composite reflector merge into a common surface along the lines 12—7 and 12—11 and intersect along the line 12—17. It should be noted that the portion of the horizontally disposed reflector which is outlined by the lines 12—19, 19—7, and 7—12 as well as the portion of the slanted reflector which is outlined by the lines 12—11, 11—20, and 20—12 are all conformable to the same paraboloid as are the common surface and the two additional surfaces previously described. The total conformal surface is indicated by the diagonally-hatched portion of FIG. 2A.

The central sectional view of FIG. 2B is taken along the line 2B—2B of FIG. 2A and is illustrative of the shape of the composite reflector just described. The curved line 22—23—24 corresponds to the curved line 3—4—5 of FIG. 1B, both representing the central section curvature of the horizontally disposed reflector. Curved line 25—22—23—26 represents the central section curvature of the slanted reflector of FIG. 2A. It should be noted that the lower portion of the slanted reflector, represented by the curved line 23—26 of FIG. 2B, lies rearward of the lower portion 23—24 of the horizontally disposed reflector. On the other hand, the upper portions (above point 23) of both reflectors lie along a common curve. The common curve is the parabola with which the common paraboloidal surface of revolution of both the horizontal and slanted reflectors is generated.

The front view of the composite reflector illustrated in FIG. 3 shows the orientation and location of the metallic reflecting strips which are employed to electrically isolate each of the component reflectors from the other. The strips bonded to the horizontally disposed reflector are positioned parallel to each other along horizontal lines while the strips of the slanted antenna are positioned parallel to each other along vertical lines. In the preferred embodiment of the present invention as previously described, the curved surface of each of the composite reflectors is made up of a plastic supporting material such as is generally utilized for antenna radomes. One material suitable for this purpose comprises woven glass fibers (commonly termed "Fiberglas") impregnated with a polyester or epoxy resin. The plastic material is transparent to microwave energy and serves merely to support and to shape the metallic reflecting strips which are bonded to it, the bonded strips comprising the active reflecting elements of the component reflectors.

In FIG. 3, the solid lines indicate the location of metallic strips on the upper surface of the unobstructed rearward plastic material as viewed in FIG. 3. The dashed lines represent the location of metallic reflecting elements on the upper surface of the rearward plastic material in those areas where the rearward plastic is shadowed by the forward portions of the composite reflector. The dot-dashed lines represent the location of the metallic strips on the under side of the plastic material of the associated forward component antennas. The stippled surface of FIG. 3 represents that surface which is common to both of the component reflectors. The under side of the common surface is coated with a metal based paint or otherwise adapted to reflect all impinging microwave energy irrespective of its polarization.

The location of the metallic strips on the upper or lower side of their respective component reflectors is arranged so that the microwave energy irradiating the reflector will travel the same predetermined electrical distance to a respective reflector as would be the case were such respec-

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tive reflectors utilized in the absence of the other component reflector. It will be recognized that although the plastic supporting material of the composite antenna is transparent to microwave energy, said material in general will have a dielectric constant which is other than that of air. The consequence is that the electrical path length traversed by impinging rays of microwave energy, on the respective metallic strips oriented to reflect the polarization of the impinging rays will depend on whether the metallic strips being illuminated are behind the transparent plastic material of the other component reflector. In other words, despite the fact that the plastic supporting material is transparent to microwave energy, its presence must be taken into account in order that there be no phase front distortion of the reflected energy from each of the component reflectors.

In view of the fact that microwave energy must first pass through the forward component reflector before being reflected by the metallic strips located on the rearward component reflector, provision is made so as to insure that all reflected microwave energy passes through two equivalent thicknesses of the supporting plastic material in its travel from the radiating horn to the reflector and back into space.

By inspection of the front view of FIG. 3, it will be seen that the surface of the horizontally disposed component reflector, outlined by lines 27—28—17 and 17—30—27, and the surface of the slanted component reflector outlined by lines 17—31—32 and 32—33—17, are not shadowed by the other component reflector. In such uncommon areas where there is no shading of one component reflector by the other, means must be provided to introduce the equivalent electrical length of the plastic supporting material. Such provision is made in the preferred embodiment of the present invention by adding sections of plastic material having no metallic reflecting strips bonded thereon, in the unshaded uncommon surface regions of the composite reflector so as to simulate the same shading effect that takes place elsewhere in the uncommon surface areas. This is shown in the front elevation view of FIG. 8 to be described later.

A clearer comprehension of the shading of portions of one of the component reflectors by portions of the other may be facilitated by inspection of FIG. 4 together with the associated end elevational view of FIG. 5. The location of the feed horns, one (47) for the horizontal reflector and the other (48) for the slanted reflector are shown in the front elevation of FIG. 4 and the end elevation of FIG. 4 and the end elevation of FIG. 5. Antenna supporting member 49, pedestal 50 and horn supporting member 51 are also indicated in FIG. 5.

As previously discussed, the horizontally disposed component reflector is adapted to reflect horizontally polarized microwave energy. Therefore, the reflecting strips bonded to the horizontal reflector are disposed along horizontal lines. Said horizontally disposed metallic reflecting strips appear in the front elevation of FIG. 4 in those areas where they are bonded to the upper side of the unshaded region of the horizontal component reflector. Similarly, the vertically disposed metallic strips of the slanted reflector also appear in FIG. 4 in those areas where they are bonded to the upper surface of the unmasked region of the slanted reflector.

No other metallic strips appear in the view of FIG. 4 for the reason that they are either bonded to the lower surface of a forward one of the component reflectors or the upper surface of a rearward one of the component reflectors. This may be seen by reference to the enlarged section of FIG. 6 which is taken along the lines 6—6 of FIG. 4. It was noted that the component reflectors of the composite reflector intersect along the line 12—17 of FIG. 4. The horizontally disposed component reflector of FIG. 4 is represented by the curved segment 34—40—35 while the slanted component reflector is represented by the curved segment 36—40—37. Inasmuch as the curved

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surface of the horizontal reflector lying on the left side of intersection line 12—17 lies rearward of the curved surface of the slanted component reflector, the reflecting strips are bonded to the upper surface of the plastic supporting material of the horizontal reflector. One such strip 38 is shown in FIG. 6.

It will be observed, however, that to the right of intersection line 12—17, the curved surface of the horizontal reflector lies forward of the slanted reflector. Consequently, the reflector strip 39 is placed on the lower surface of the horizontal antenna to the right of intersection line 12—17 in order that impinging microwave energy traverses the same thickness of plastic supporting material irrespective of whether the rays of said impinging energy are directed to the left or to the right of intersection line 12—17. To the left of the intersection line the rays must pass through the region 36—40 of the slanted reflector before being reflected by strip 38. To the right of the intersection line the rays must pass through an equivalent thickness of plastic material in the region 40—35 of the horizontal reflector before being reflected by strip 39.

The vertically disposed strips of the slanted reflector are positioned on the lower and upper surfaces of the plastic material of the slanted reflector in analogous fashion. Only the ends of the vertical strips appear in FIG. 6. To the left of intersection line 12—17, said strips are bonded to the lower surface of the plastic material of the slanted reflector while to the right of the intersection line the strips are bonded to the upper surface of the slanted reflector. When rays of vertically polarized microwave energy impinge on the slanted reflector to the left of the intersection line, they must pass twice through a single thickness of the plastic supporting material of the slanted reflector in the region 36—40. To the right of the intersection line the rays of vertically polarized microwave energy must twice pass through a single thickness of the region 40—35 of the horizontal antenna. Accordingly, the vertically disposed strips are mounted on the under surface of the slanted reflector to the left of the intersection line, and on the upper surface of the slanted reflector to the right of the intersection line.

The location of the reflecting strips is further illustrated in the enlarged sectional view of FIG. 7 which is taken along the line 7—7 of FIG. 4 lying to the right of intersection line 12—17. The horizontally disposed reflecting strips 41 are bonded to the lower surface of the forward portion of the horizontal component reflector. The vertically oriented reflecting strips 42 are affixed to the upper surface of the rearward portion of the slanted component reflector. The lower surface of the common portion of the composite reflector between points 43 and 44 is covered with a metal-based paint 45. Vertically disposed reflecting strips are bonded to the lower surface of the slanted antenna in the region 43—46.

FIG. 8 illustrates the addition of two sections of plastic material in the uncommon unshaded regions of the composite antenna to create a shading effect similar to that obtaining elsewhere in the uncommon shaded regions. The plastic material is preferably added to the curved edge 17—52—53 of the forward horizontal reflector and to the curved edge 17—54—55 of the forward slanted reflector of FIG. 4 so as to preclude the direct irradiation by the feed horns 47 and 58 of the reflecting strips in those unshaded areas of the component reflectors where the strips are mounted on upper plastic surfaces. FIG. 8 is cut away at the lower extremities to expose the reflecting strips 56 and 57 now being shaded by the added plastic material.

Because the major axis of the horizontally disposed component reflector is oriented along a horizontal line and inasmuch as said reflector is adapted to reflect horizontally polarized microwave energy, there is no problem in illuminating the horizontally disposed component reflector by a conventional flared horn adapted to radiate horizontally polarized microwave energy. In the case of the slanted component reflector, however, a problem arises in

that the major axis of the slanted reflector is oriented at 45° relative to the polarization of the microwave energy to be reflected by it. It can be seen that in the case of the slanted reflector, its respectively associated illuminating horn must be capable of radiating a generally fan-shaped beam of microwave energy whose major dimension lies along a line oriented at 45° to the direction of energy polarization.

A suitably adapted feed horn capable of producing the required beam shape and energy polarization for the slanted reflector is shown in FIG. 9. In FIG. 9, a linearly polarized wave of microwave energy is fed into the throat of feed horn 58 by means of a conventional rectangular waveguide adaptor (not shown). The linearly polarized energy is represented by the two orthogonal components 59 and 60 which share a common amplitude and phase. The rectangular throat of horn 58 is flared into a larger rectangular radiating aperture 61.

Horn 58 may be considered as being a superposition of two rectangular horns. By incorporating sets of parallel fins 62 and 63, two independent apertures are maintained. The microwave energy component represented by the vector 59 "sees" a rectangular horn aperture having vertices designed by the numerals 64, while the other component of microwave energy represented by the vector 60 "sees" a rectangular horn aperture having vertices designated by the numeral 65.

Upon the combination of these two orthogonally polarized waves in space, a resultant single field, represented by the vector 66, is realized. The resultant vector 66 may be oriented at any arbitrary angle including the angle of 45° by the adjustment of mutual amplitude between the two input orthogonal vectors 59 and 60. Additionally, an elliptically or circularly polarized resultant microwave energy field may be produced in space by the adjustment of mutual electrical phase between the input microwave energy components represented by vectors 59 and 60.

In short, when the horn aperture 61 major axis of symmetry is arranged parallel to the slanted reflector axis of symmetry as shown in FIG. 4, there is achieved uniform illumination of the slanted reflector by microwave energy polarized along lines parallel to the vertical reflecting strips bonded to the slanted component reflector.

From the preceding it can be seen that the objects of the present invention have been achieved by the provision of a composite microwave energy directive element comprising two components reflectors, each conforming in part to the same figure of revolution. The composite reflector is generated by the rotation of one of the component reflectors, relative to the other, through a predetermined angle about the axis of revolution of the figure of revolution. Positive electrical isolation of one component reflector from the other is achieved by the provision of polarization sensitive reflecting elements such as strips which are bonded to the plastic supporting material of the respective component reflectors. In the disclosed preferred embodiment of the present invention, provision is made for the optimum location of reflecting strips on their respective component reflectors so as to equalize path length traversed by impinging rays of microwave energy during the course of travel from a respective one of a pair of irradiating horns to the associated component reflector and then back out into space. Each of the horns is adapted to transmit microwave energy which is polarized orthogonally to the energy emitted by the other. Additionally, a specially suited horn is provided for the slanted component reflector whereby the reflector illumination and energy polarization requirements are fully met.

It should be noted that although polarization-sensitive reflecting strips have been shown mounted on the uncommon shaded surfaces of the component reflector, said surfaces alternatively but less preferably may be covered by a reflecting material insensitive and nondiscriminatory to the polarization of incident microwave energy. Inasmuch as the forward portions of the uncommon surface

areas selectively reflected a respective one of the two orthogonally polarized beams, the rearward shaded portions are irradiated primarily by only the other cross-polarized one of the incident beams which passes through said forward portions. However, as a practical matter, not all of the properly polarized beam energy may be reflected by the strips on the forward surfaces. Therefore, if the rearward surfaces were totally reflective, i.e., not polarization discriminatory, the undesired energy component which passes through the forward surfaces might give rise to objectionable side lobes in the beam formed by the rearward surfaces. When both the forward and rearward surfaces are made polarization-sensitive, the improperly passed energy component which penetrates the forward reflecting surfaces is readily passed also by the rearward surfaces which is adapted to maximally reflect energy polarized orthogonally to the improperly passed component.

For the sake of simplicity and clarity, two identically shaped component reflectors are utilized in the illustrated embodiment of the composite reflector. It should be understood, however, that the component reflectors need not be identical provided that each contains a surface portion which is conformal to the same figure of revolution. The remaining surface portions may be independently shaped to meet the requirements of the individual beam patterns which each component reflector is to respectively generate.

While the invention has been described in its preferred embodiments, it is to be understood that the words which have been used are words of description rather than of limitation and that changes within the purview of the appended claims may be made without departing from the true scope and spirit of the invention in its broader aspects.

What is claimed is:

1. A composite microwave energy directive element comprising two component microwave energy directive elements, each containing a surface portion which is conformal to the same surface of revolution, one of said directive elements being rotated through a predetermined angle relative to the other about the axis of revolution of said surface of revolution, said composite element containing a surface portion of said surface of revolution which is common to both of said component elements, each of said component elements being adapted to direct only a predetermined one of two orthogonally polarized incident beams of microwave energy.

2. A superimposed polarization isolated shaped reflector for microwave energy comprising two component microwave energy reflectors, each containing a surface portion which is conformal to the same surface of revolution, one of said reflectors being rotated through a predetermined angle relative to the other about the axis of revolution of said surface of revolution, said superimposed reflector containing a surface portion which is conformal to said surface of revolution and common to both of said component reflectors, each of said component reflectors being adapted to reflect only a predetermined one of two orthogonally polarized incident beams of microwave energy.

3. A composite microwave energy directive element comprising two component microwave energy directive elements, each containing a surface portion which is conformal to the same surface of revolution, one of said directive elements being rotated through a predetermined angle relative to the other about the axis of revolution of said surface of revolution, said composite element containing a first surface portion of said surface of revolution which is common to both of said component elements, and second surface portions uniquely associated with a respective one of said component elements, said common portion being adapted to direct both of two orthogonally polarized incident beams of microwave energy, and said

uniquely associated portions being adapted to direct only a respective one of said two incident beams.

4. A superimposed polarization isolated shaped reflector for microwave energy comprising two component microwave energy reflectors, each containing a surface portion which is conformal to the same surface of revolution, one of said reflectors being rotated through a predetermined angle relative to the other about the axis of revolution of said surface of revolution, said superimposed reflector containing a first surface portion which is conformal to said surface of revolution and common to both of said component reflectors, and second surface portions uniquely associated with a respective one of said component reflectors, said common portion being adapted to reflect both of two orthogonally polarized incident beams of microwave energy, and said uniquely associated portions being adapted to reflect only a respective one of said two incident beams.

5. A superimposed polarization isolated shaped reflector for microwave energy for use in a V-beam radar system, comprising two component microwave energy reflectors, each containing a surface portion which is conformal to the same paraboloidal surface of revolution, one of said reflectors being rotated through an angle of substantially 45° relative to the other about the axis of revolution of said surface of revolution, said superimposed reflector containing a first surface portion which is conformal to said paraboloidal surface of revolution and common to both of said component reflectors and second surface portions uniquely associated with a respective one of said component reflectors, said common portion being adapted to reflect both of two orthogonally polarized incident beams of microwave energy and said uniquely associated portions being adapted to reflect a respective one of said two incident beams whereby mutually independent reflected beams of orthogonally polarized microwave energy are produced in space.

6. A superimposed polarization isolated shaped reflector for microwave energy comprising two component shaped supporting members, each member consisting of material transparent to incident beams of orthogonally polarized microwave energy, each of said members containing a surface portion which is conformal to the same surface of revolution and having an axis of symmetry bisecting said surface of revolution, one of said members being rotated through a predetermined angle relative to the other about the axis of revolution of said surface of revolution, said members, after rotation, containing a surface portion which is conformal to said surface of revolution and common to both and uniquely associated additional surface portions, first means conformably mounted on said common portion for reflecting both beams of

said orthogonally polarized microwave energy, second means conformably mounted on said additional surface portions of one of said members for selectively reflecting only a predetermined one of said orthogonally polarized beams, third means conformably mounted on said additional surface portions of the other of said members for selectively reflecting only the other of said orthogonally polarized beams, and first and second means for respectively illuminating said first and second members with said orthogonally polarized microwave energy.

7. Apparatus as defined in claim 6 wherein one of said illuminating means is adapted to emit a linearly polarized beam of microwave energy having a plane of polarization obliquely related to the axis of symmetry of one of said members.

8. A composite microwave energy directive element for use in a V-beam radar system comprising two component shaped supporting members, each member containing a surface portion which is conformal to the same surface of revolution and consisting of material transparent to incident beams of orthogonally polarized microwave energy, one of said members being rotated through a predetermined angle relative to the other about the axis of revolution of said surface of revolution, said members, after rotation, containing a surface portion which is conformal to said surface of revolution and common to both and uniquely associated additional surface portions, first means conformably mounted on said common portion for reflecting both beams of said orthogonally polarized microwave energy, second means conformably mounted on said additional surface portions of one of said members for selectively reflecting only a predetermined one of said orthogonally polarized beams, and third means conformably mounted on said additional surface portions of the other of said members for selectively reflecting only the other of said orthogonally polarized beams whereby mutually independent reflected beams of orthogonally polarized microwave energy are produced in space.

9. Apparatus as defined in claim 8 wherein said second and third selectively reflecting means are mounted on the respective surfaces of the associated ones of said supporting members so as to equalize the electrical path length traversed by said incident beams of microwave energy during the course of production of said mutually independent reflected beams.

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