

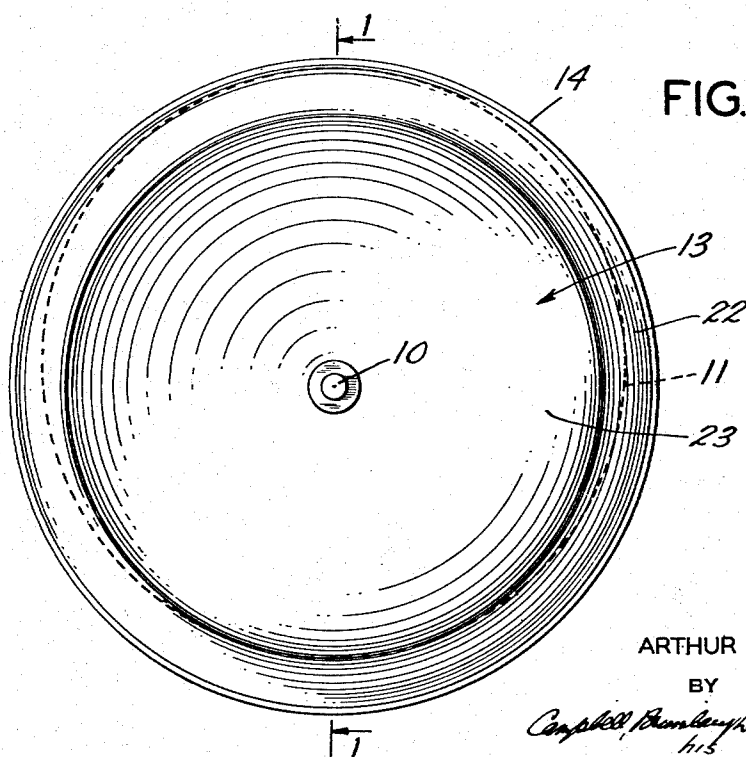
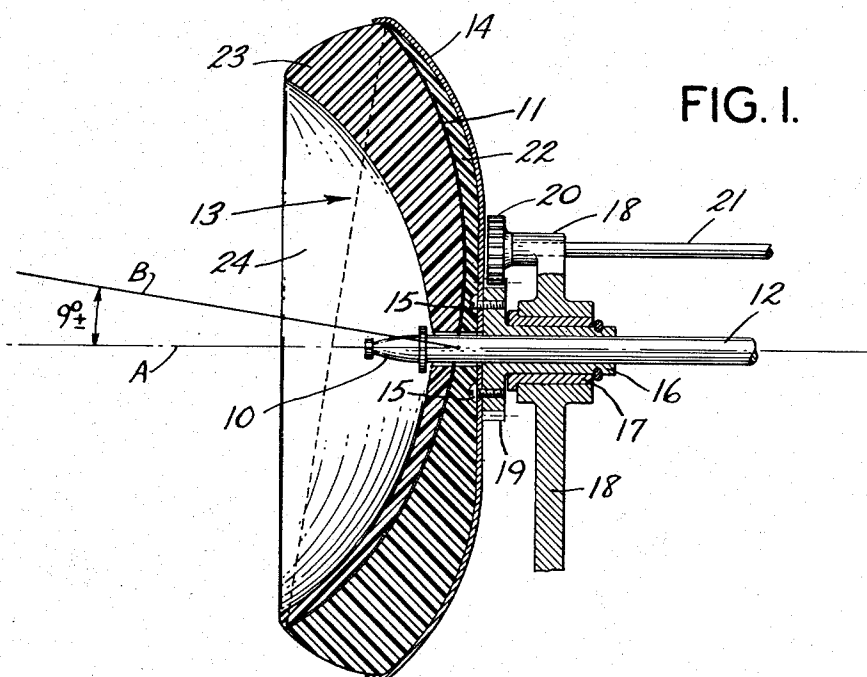
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SCANNING DEVICE

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SCANNING DEVICE

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This invention relates to scanning devices, and has particular reference to parabolic scanning reflectors for radar apparatus.

In order to scan the area in front of a radar antenna, it has become the practice to angularly offset the axis of the reflector from the axis of the antenna so that the reflector is tilted, and then rotate the resulting asymmetric reflector at relatively high speed about the stationary antenna. Because of the tilt of the reflector relatively to the axis of its rotation, the reflector and the corresponding beam tilt continuously or wobble about the axis of rotation to cover a materially larger scanning area than the cross-sectional area of the beam itself.

Although the asymmetric reflector is very effective in affording a large scanning area, the dynamic unbalance caused by the tilt of the rotating reflector becomes serious as the speed of rotation of the reflector increases, particularly when airborne. Dynamic unbalance is due to forces caused by the eccentric center of mass of the reflector, windage and air density variations, each of which becomes critical at high rotational speeds of the reflector and the resulting vibration may cause structural failure and higher driving power requirements. The expedient of dynamically balancing the reflector by the application of weights counterbalancing the eccentric center of mass is impractical and may aggravate the unbalance when the elevation of the device changes in flight.

In accordance with the present invention, an asymmetric radar scanning device is provided whose rotating reflector is and remains dynamically balanced throughout a very wide range of rotational speeds and under widely varying windage and air density variations.

In a preferred embodiment of the invention the tilting parabolic reflector is imbedded in solid dielectric material shaped in the form of a cylinder mounted coaxially with the axis of rotation of the reflector which it encloses. Preferably, the dielectric material is a moldable plastic which becomes porous on setting so as to be light in weight and yet having sufficient strength and rigidity to withstand high rotational speeds and to support the metallic reflector so that it may be made of lightweight metal foil, thus making the entire reflector-casing combination lightweight so as to reduce driving power requirements.

It will be seen that the dynamically-balanced asymmetrical radar scanning device of this invention may be utilized in any desired environ-

ment without impairment of its function by reason of change of orientation, elevation, or speed of rotation, these advantages being due to the smooth symmetrical surface and dynamic balance of the rotating scanning device, which also enable it to be rotated at very high speeds without vibration, thereby materially increasing the scanning rate and improving the signal over noise level ratio.

For a more complete understanding of the invention, reference may be had to the accompanying drawings, in which:

Figure 1 is an axial cross-section through the scanning device of this invention as seen along the line 1—1 of Fig. 2; and

Fig. 2 is a face view of the new scanning device.

Referring to the drawings, numeral 10 designates a radar antenna which does not rotate, but about whose axis A the parabolic reflector 11 rotates, but with its focal axis or its axis of revolution B tilted at an angle, say 9°, to the axis A of the antenna 10 and its supporting conduit 12 containing the conductors leading to the electronic equipment, not shown.

The parabolic reflector 11 is carried by the rotating, generally cylindrical unit designated 13, which includes a dished backing plate 14 of relatively rigid pressed sheet metal, which is secured by screws 15 to the flange of a hub 16 journaled in bearing 17 mounted in a frame 18, which preferably is carried in a conventional gimbal suspension, forming no part of this invention, but enabling the unit 13 and the antenna 10 to be oriented at any desired angle.

A spur gear 19 is formed on or secured to the flange of the hub 16 and is engaged by a pinion 20 journaled in frame 18 and driven by a shaft 21 from an electric motor, also carried by the gimbal suspension, and not shown. By means of the shaft and gear train 19—20, the unit 13 is rotated about the axis of the antenna 10 at very high speeds, which are made possible by this invention, as will be described.

The cylindrical unit 13, including the parabolic reflector 11 and backing plate 14 also includes a cylindrical mass of dielectric material encasing the reflector 11 and preferably composed of a synthetic resin having lightness, strength and hardness, and capable of being machined or otherwise cut to shape. A suitable material is foam "Hycar" which is a butadiene-acrylonitrile copolymer or a butadiene-styrene copolymer which has been expanded into a hard, non-permeable, cellular mass of low density. Another suitable material of similar characteristics is

"Styrofoam," which is an expanded polystyrene.

The resinous cylinder is preferably formed in two complementary components, 22 and 23, positioned on opposite sides of the reflector 11. The rear or inner component 22 is bonded or otherwise secured to the inner surface of the backing plate 14 to a substantial thickness with its exposed surface molded or subsequently machined to conform to the concave configuration of the rear of the parabolic reflector 11, when its focal axis B is tilted at an angle to the axis of rotation of the backing plate 14 which is coaxial with the axis of the antenna A, as indicated in Fig. 1.

Similarly, the second or front component 23 of the initially plastic material is molded, or shaped by machining, so that its rear surface has a parabolic convexity about the axis B mating or complementary with the parabolic concavity of the rear component 22. Preferably, the outer surface of the front component 23 is dished at 24 to avoid excessive or unnecessary weight.

Having formed the components 22 and 23 described, they mate to jointly form a rigid support for the parabolic reflector 11 which accordingly may be metal foil such as aluminum or tin foil, or the like. By making the reflector 11 of tinfoil, the reflector 11 need not be separately formed but partakes of the parabolic contour of mating parts 22 and 23 and does not add appreciably to the weight of the rotating unit 13. Instead of metal foil, a metallic layer may be otherwise applied to the parabolic surface of component 22 or 23 as by spraying the metal in molten state thereon, or applying it as a paint in which the finely-divided metal is dispersed, or the like. Thereafter, the metal reflector 11 and the two respective concave and convex components 22 and 23 are cemented together into the single, cylindrical, rigid unit 13 which is bored centrally to provide an aperture through which the stationary antenna conduit 12 passes, as shown in Fig. 1.

Alternatively, the parabolic reflector 11 may be made of thin but self-sustaining material such as sheet metal pressed to shape between parabolic dies and may serve as a form against which the initially plastic material forming components 22 and 23 may be cast or molded or otherwise formed, while the reflector is inclined with its focal axis B disposed at an angle to the axis A, as described. As another variation of the method of forming the unit 13, a self-sustaining reflector 11, properly oriented at the required angle, may be encased within a mass of the resinous material while plastic so that the unit 13 is formed in one step when the resin hardens.

However the cylindrical unit 13 is formed, it is then trued about axis A by machining and is otherwise adjusted so that it is smooth and its mass is distributed uniformly about the axis of rotation A to afford dynamic balance at all speeds and angles of orientation of axis A.

In operation of the apparatus of this invention, rotation of the tilted reflector 11 by driving gearing 19, 20 about the axis of rotation A causes it to wobble asymmetrically. In view of the fact that the symmetrical encasing cylinder 22, 23 places the asymmetric reflector 11 in dynamic balance, no vibration ensues nor is the balance changed during changes in elevation causing a change in air density, as when the unit is airborne. By reason of the dynamic balance of unit 13, and its smooth and sym-

metrical outer surface, very much higher rotational speeds and more efficient scanning are possible than has been realized heretofore because of excessive vibration at high speeds caused by dynamic unbalance of the rotating parts. Also because of the smooth and symmetrical outer surface of the rotating unit 13, 14, the acoustical noise level is materially reduced over that of prior scanning devices.

Although the invention is particularly directed to radar scanners with parabolic reflectors, it has other utility and the term "parabolic reflector," as used herein is equally applicable to conoids, hyperboloids, spheroids, ellipsoids, and other surfaces of revolution.

Although a preferred embodiment of the invention has been illustrated and described herein, it is to be understood that the invention is not limited thereto, but is susceptible to changes in form and detail within the scope of the appended claims.

I claim:

1. In a radar scanning device having an antenna and a reflecting surface and adapted to be rotated about an axis which is inclined to the axis of revolution of its reflecting surface and which is coincident with the axis of the cooperating antenna, the combination of a concave metallic reflector, a symmetrical body of dielectric material massed on opposite surfaces of said reflector and encasing the reflector and having its symmetrical axis coincident with the axis of rotation of the reflector, whereby the rotating assembly of the asymmetric reflector and the symmetric body is dynamically balanced about the said axis of rotation, means supporting said body for rotation about said axis of rotation, and driving means for rotating said body about said axis of rotation.

2. In a radar scanning device having an antenna and a reflecting surface and adapted to be rotated about an axis which is inclined to the axis of revolution of its reflecting surface and which is coincident with the axis of the cooperating antenna, the combination of a concave thin sheet metal reflector, a symmetrical body of dielectric material formed of two mating blocks having respective concave and convex surfaces coextensively engaging the corresponding opposite surfaces of said reflector and jointly encasing the reflector and having its symmetrical axis coincident with the axis of rotation of the reflector, whereby the rotating assembly of the asymmetric reflector and the symmetric body is dynamically balanced about the said axis of rotation, means supporting said assembly about said axis of rotation, and driving means for rotating said assembly about said axis of rotation.

3. In a radar scanning device adapted to be rotated about an axis which is inclined to the axis of revolution of its reflecting surface and which is coincident with the axis of the cooperating antenna, the combination of a concave thin sheet metal reflector, a pair of mating blocks of dielectric material having respective concave and convex surfaces conforming to the contours of the corresponding opposite surfaces of said reflector, means securing said blocks together with their respective convex and concave surfaces in coextensive engagement with the corresponding opposite surfaces of said reflector for encasing the reflector, the body of material constituting said blocks being distributed uniformly about the axis of rotation of

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the reflector, whereby the rotating assembly of the asymmetric reflector and the symmetric body of dielectric material is dynamically balanced about the said axis of rotation, means supporting said assembly for rotation about said axis of rotation, and driving means for rotating said assembly about said axis of rotation.

4. A radar scanning device comprising a metal-foil parabolic reflector adapted to be rotated about a relatively fixed axis and having its focal axis inclined at an angle thereto, and a mass of dielectric material formed of complementary parts engaging the opposite surfaces of said reflector and jointly encasing said reflector and distributed uniformly about the said relatively fixed axis for supporting said reflector, and means supporting said mass for rotation about said relatively fixed axis, whereby the symmetrical mass effects dynamic balance of said reflector during rotation thereof.

5. A radar scanning device comprising a metallic parabolic reflector adapted to be rotated about a relatively fixed axis and having its focal

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axis inclined at an angle thereto, a mass of dielectric material formed of two mating blocks having respective concave and convex surfaces coextensively engaging the corresponding opposite surfaces of said reflector and jointly encasing said reflector and distributed uniformly about the said relatively fixed axis for effecting dynamic balance of said reflector during rotation thereof, and means supporting said mass for rotation about said axis.

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