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PARABOLIC REFLECTOR WITH RIM OF ABSORBING MATERIAL TO ATTENUATE SIDE LOBES

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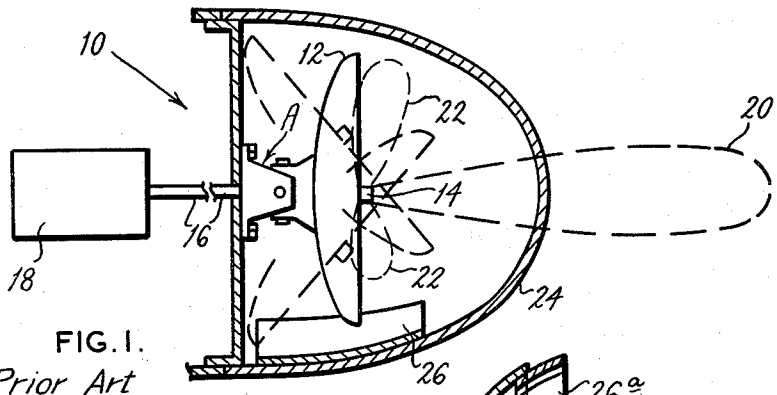


FIG. 1.
Prior Art

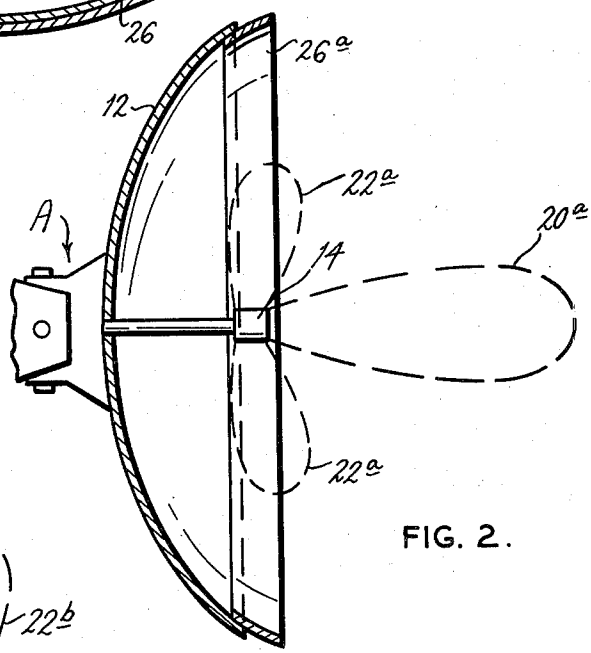


FIG. 2.

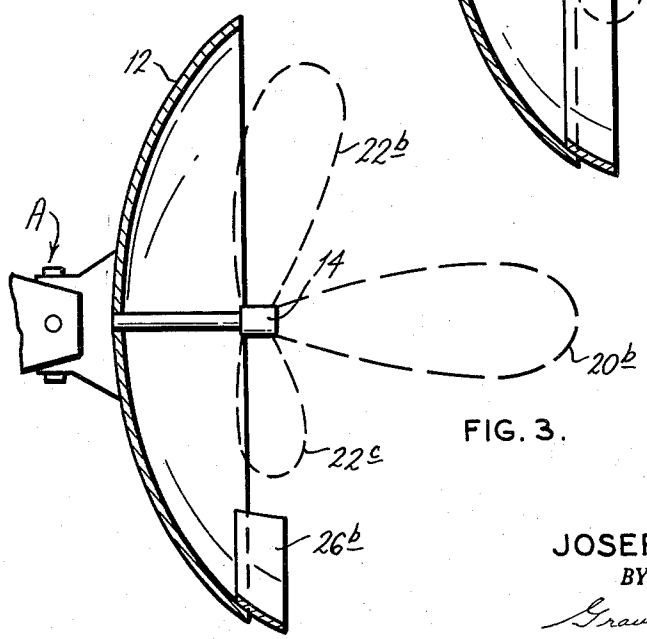


FIG. 3.

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PARABOLIC REFLECTOR WITH RIM OF ABSORBING MATERIAL TO ATTENUATE SIDE LOBES

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The present invention relates generally to devices for shaping the radiation pattern of an antenna and more particularly to radar antenna radiation pattern shaping means.

Various means have been devised in the past to eliminate or at least to reduce antenna radiation in a particular direction. The known means have included radiation absorbing devices which are mounted adjacent to the antenna to absorb radiation in a chosen direction. In the known constructions the radiation absorbing material has been fixedly attached to an immovable object adjacent to the antenna such as a radome but has not been satisfactory for use with moving antenna structures such as the antenna structures employed with radar gear because movement of the antenna changes the relative position of the absorbing material with respect to the antenna and thereby changes the direction of maximum radiation absorption relative to the radiation pattern. If the antenna is moved through a large enough angle the main antenna beam may actually be directed at the absorbing material and be undesirably attenuated while the side radiation which it is intended to be absorbed is unaffected. Another major problem of known radiation absorbing elements has been their inability to withstand intense radiation resulting in a functional breakdown when located in a strong electromagnetic field. These and other disadvantages of the known devices are overcome by the present device which comprises an antenna located adjacent to said radiator, and means mounted on the antenna structure for attenuating radiation therefrom in a chosen direction relative to the antenna.

It is the principal object of the present invention therefore to provide means for reducing antenna radiation in a chosen direction, such as the side lobes of the radiation pattern so that the effective radiation is concentrated as desired.

Another object is to uniformly reduce antenna radiation in a chosen direction relative to the antenna regardless of the direction in which the antenna is facing.

Another object is to maintain a constant relationship between a main antenna radiation beam and a secondary or side lobe.

Another object is to provide an inexpensive, lightweight and compact device capable of absorbing antenna radiation, which device is capable of withstanding large amounts of radiation without breaking down and which can be installed on new or existing antenna structures with minimum effort.

Another object is to provide a radiation absorbing device for an antenna which reduces radiation therefrom in a chosen direction without reducing, distorting or bending the radiation in other directions.

Another object is to provide a radiation absorbing device which can be mounted on moving antenna structures and moved therewith.

Still another object is to increase the accuracy of radar antennae and the like by maintaining a constant fixed relationship between the magnitude of the principal radiation lobe and the side lobes.

These and other objects and advantages of the present invention will become apparent after considering the following detailed specification in conjunction with the accompanying drawing.

In the drawing:

FIG. 1 is a longitudinal sectional view of an antenna mounted in a radome for movement about different axes relative to radiation absorbing means fixed in the radome which is representative of the prior art;

FIG. 2 is a cross-sectional view of an antenna equipped with radiation absorbing means which moves with the movable portion of the antenna assembly; and

FIG. 3 is a view similar to FIG. 2, but illustrating the application of the radiation absorbing means to a particular zone.

Referring to the drawing more particularly by reference numbers, the number 10 refers to an antenna assembly constructed according to the teachings of the prior art. The antenna 10 has a parabolic reflector or shield 12, a radiator 14 mounted centrally adjacent the concave side of the reflector 12, and suitable leads 16 connecting the radiator 14 to a radar set 18 or similar radiation transmitting device. The reflector 12 is movably carried on a universally pivoting device A.

When energy is fed to the radiator 14 from the radar set 18 it is radiated therefrom in a pattern, the characteristics of which depend upon the characteristics of the antenna components including the radiator and the reflector, the characteristics of the signal itself, and also the characteristics of the surrounding structures and their location relative to the antenna.

In FIG. 1 the pattern is assumed to consist of a main or forward radiation beam 20 which extends straight out from the antenna, and side lobes which are contained in an annular envelope shown at 22. In the more generalized situation there will be a number of side lobes, but for the sake of this invention these side lobes are dealt with as one general side lobe 22, which forms the envelope of all side lobes.

The prior art involved attenuating the side lobe 22 in a local area, say on the down side, by fixing in the radome 24 absorbing material 26 which attenuated the radiations passing through the same, thereby reducing the effect on the scope pattern of the reflection from the ground or object at the chosen side of the antenna. The difficulty with this system is that when the reflector 12 moves to face the material 26 the main lobe 20 is attenuated which is undesirable. When the reflector moves to face away from the material 26 the side lobe attenuation is reduced or eliminated. In order to overcome the difficulty with prior art devices and to be able only to reduce the magnitude of the side lobe in a given direction or portion of the annular envelope 22 depicted in FIG. 1, radiation absorbing material 26*a* is mounted on the reflector 12 as shown in FIG. 2, or as shown at 26*b* in FIG. 3. Any suitable radiation absorbing material can be used for this purpose provided it can withstand the intensity of the radiation without breaking down. Heretofore, the absorber material of FIGS. 1, 2 and 3 consisted of a section of foam rubber with graphite therein and having a ply of aluminum foil on one surface.

A particular application where the present device has been found useful is in connection with the radar systems employed on airplanes. In such devices not only is it important to properly modify the radiation pattern in given directions but it is also important that the size and weight of the equipment be kept at a minimum. During a typical tracking operation, for example, using an airplane radar set, the radar antenna main beam is directed to a remote airborne target. The main beam 20*a* thus directed, is reflected from the target and picked up by the same antenna. At the same time energy is also being radidated in the form of side lobes 22*a*. When the attenuation material 26*a* is extended about the lip of the reflector 12 (FIG. 2) the envelope of side lobes 22*a* is substantially attenuated in all directions. However, in FIG. 3

the envelope of side lobes is differently shaped at 22*b* from the lobe at 22*c*, since part of the side lobe energy is radiated downwardly and reflected from the earth's surface. The reflected energy received from the target area, and from the earth's surface as a result of the side lobe energy, is fed to the radar set 18 and their presence made known in the form of images on a radar scope. The radar scope is usually calibrated in azimuth and range.

The pictorial representations on the scope appear as a line which is referred to as the "altitude line" and which extends across the face of the scope as if it were a target at a range corresponding to the aircraft altitude, and as a target or bright spot. As the aircraft closes on the target, the range to the target decreases and the target must pass through the altitude line. It is important to proper tracking that the intensity of the power reflected from the target and received by the radar antenna be of much higher magnitude than the power the antenna receives which has been reflected from the earth. This difference in intensity will insure that the radar remains locked on the target as the target passes through the altitude line. In this regard it should be noted that the power due to noise and earth reflections is due in large part to the strength of the side lobe reflections. If the reflected energy due to the side lobes is large, the power which contributes to the altitude line will be large and it will be more difficult for the tracking radar to distinguish between the altitude line and target and "lock on" may be lost as the target passes through the altitude line. When this condition exists it becomes difficult if not impossible to successfully track.

As previously noted, to insure satisfactory tracking, the power received from the target signal must be appreciably greater than the power received from the earth's signal. The ratio of the power received from the earth and the power received from the target depends on the reflecting areas of the reflecting bodies and the gain of the antenna when power is received from a particular direction. The ratio of the observed area of the earth to the observed target area is a factor which cannot be controlled. Therefore, in order to have an appreciably stronger signal from the target than from the earth, some means must be devised to reduce the amount of energy radiated in and received from the side lobes without reducing the energy directed by the main beam at the target. A prior art example is illustrated in FIG. 1, wherein the radiation absorbing material 26 is mounted in a fixed position relative to the antenna 12 mounted on the universally pivoting device A within the radome 24 of an airplane. This has worked satisfactorily during level flight but not otherwise because during certain flight attitudes the antenna 12 would actually be turned to direct the main lobe 20 through the absorbing material 26. At other times the reflector 12 is turned away from the absorbing material so that the apparatus might produce results exactly opposite from the desired result, or having little or no effect at all.

The present invention overcomes these disadvantages by mounting absorbing or attenuating material 26*a* on the antenna reflector 12 so that it moves with the reflector and not relative thereto. Therefore, regardless of the attitude of the airplane or the direction in which the antenna reflector is facing, the reflector never faces toward or away from the absorbing material. The purpose of applicant's device then is to attenuate the side lobe power that otherwise would be radiated toward the earth or some other body so that the reflected energy received by the main lobe will always be substantially greater than the energy received from the side lobes.

While the present invention has been described in connection with its broad application (FIG. 3) and in a specific antenna construction (FIG. 2), it is obvious that it can also be used with many other antenna structures and for many other applications without departing from the spirit and scope of the invention.

I claim:

1. For use with an aircraft radar set having a scope, an antenna comprising a substantially round parabolic concave reflector having a forwardly extending central axis and a peripheral edge, a radiator element, means securing said radiator element to said reflector and forwardly of said peripheral edge of said reflector on said axis, said radiator in combination with said reflector being capable of producing a forward energy lobe orientated on the axis of said reflector and side lobe energy orientated adjacent to the peripheral edge of said reflector and extending generally radially of said axis, an elongated arcuate strip of radiation absorbing material curved substantially the same degree as said peripheral edge, said strip having an axially inner edge portion telescopically received within the peripheral edge of said reflector, means fixedly securing said edge portion of said strip to the peripheral edge of said reflector, said strip being flared in relation to said axis so that said edge portion fits flush against and parallel to the peripheral edge of said reflector, the remainder of said strip flaring radially outwardly and axially forwrdly from said reflector so as to be in radial alignment with said radiator whereby the side energy lobe passes through said strip and is attenuated thereby, said strip attenuating said side lobe energy to a degree whereby when said forward energy lobe and said side lobe energy are reflected from an airborne target and earth respectively, images of substantially the same brightness are produced on said scope, universal joint means connected to said reflector and adapted to be secured to a support, said universal joint means permitting said reflector, radiator and absorbing strip of material to be moved as a unit in any direction relative to the base whereby the absorbing strip of material is always in the path of said side lobe energy and never in the path of said forward energy lobe.

2. An antenna as defined in claim 1, wherein said universal joint means includes a first pivot means having an axis perpendicular to and extending through the antenna axis, and a second pivot means having an axis intersecting and perpendicular to both said antenna axis and said first axis.

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