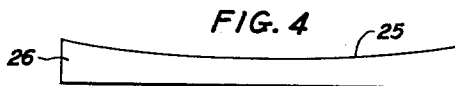
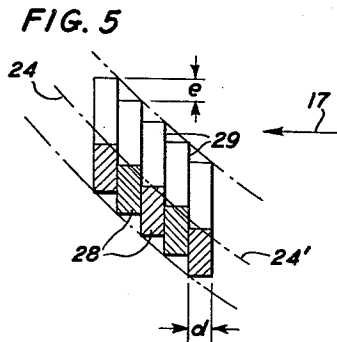
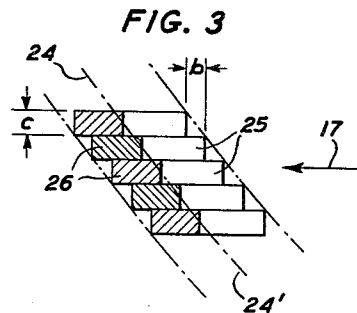
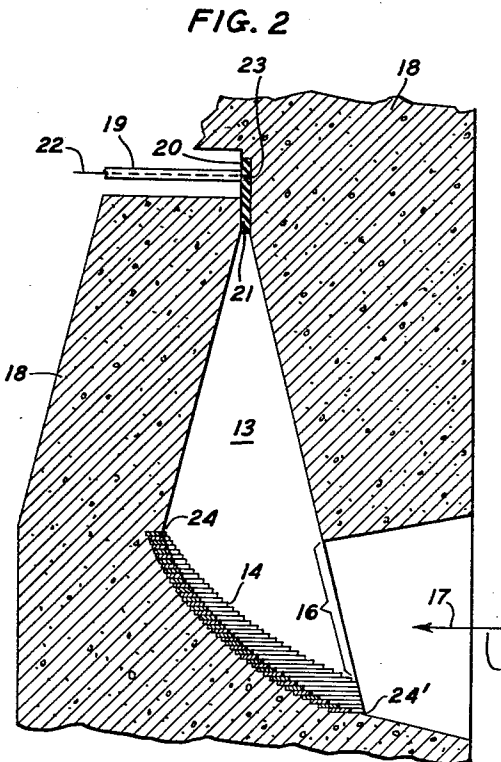
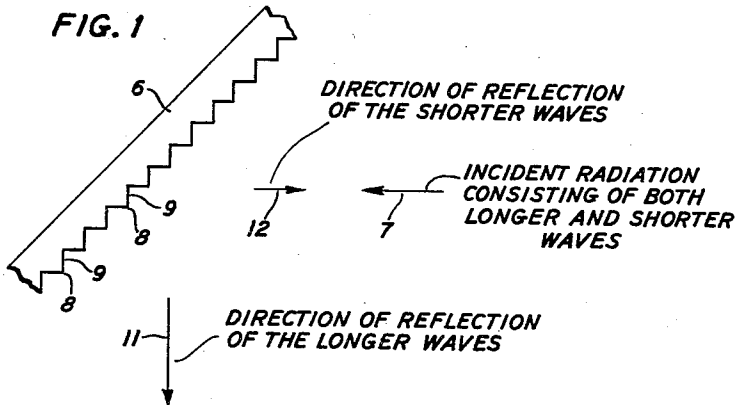


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R. A. EISENTRAUT
GROOVED REFLECTING SURFACE FOR DISCRIMINATING
BETWEEN THERMAL AND MICROWAVE RADIATION
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INVENTOR
R. A. EISENTRAUT
BY
Ralph P. Wolcomb
ATTORNEY

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GROOVED REFLECTING SURFACE FOR DISCRIMINATING BETWEEN THERMAL AND MICRO-WAVE RADIATION

Rudolph A. Eisentraut, Menlo Park, Calif., assignor to Bell Telephone Laboratories, Incorporated, New York, N.Y., a corporation of New York

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This invention relates to antenna systems, and more particularly to an antenna reflector which has different reflecting properties for incident electromagnetic radiation of different wavelengths.

An object of the invention is to separate electromagnetic radiation of one wavelength from accompanying radiation of a different wavelength. A more specific object is to focus selected incident waves at a focal area while reflecting much shorter undesired waves in a direction to avoid the focal area.

Many antenna systems comprise a reflector of the parabolic or paraboloidal type which is illuminated with microwave radiation by a feed horn located at the focal point. All incident radiation arriving from a direction parallel to the axis of the parabola is focused at this point. If this incoming energy includes thermal radiation from a nearby nuclear explosion, this thermal radiation is also concentrated at the focal point. The resulting rise in temperature in that region will vaporize or otherwise damage portions of the feed system, and put the antenna out of operation.

The present invention greatly reduces this hazard. Advantage is taken of the fact that the thermal radiation is much shorter in wavelength than is the desired incoming signal. Therefore, the surface of the reflector is provided with steps or grooves so small that the reflection of the signal waves is substantially unaffected by their presence. Thus, the signal waves are focused on the feed horn in the usual manner. However, each of the steps has a side facing the incident radiation. Each side has a width at least equal to the longest wavelength of the undesired thermal radiation. Most of the thermal energy is thus reflected harmlessly back toward its source instead of being focused on the feed horn.

The antenna system disclosed herein, by way of example only, is of the horn-reflector type, comprising a tapered horn with a stepped reflector at the larger end. The incident radiation enters the horn through an opening in one side near the reflector. The longer, signal waves are focused by the reflector at the focal point in the throat of the horn. A wave guide conducts this energy from the throat to a probe connected to a coaxial transmission line. The guide is filled with dielectric material to protect the probe from excessive heat and pressure. Any accompanying thermal energy is reflected back through the horn opening, thus avoiding damage to the feed system. To increase the strength of the antenna structure, it may be embedded in reinforced concrete, and the stepped reflector may be constructed of stacked steel plates. The portions of the plates facing the thermal blast are preferably polished or chrome-plated to improve their reflectivity.

The nature of the invention and its various objects, features, and advantages will appear more fully in the following detailed description of a typical embodiment illustrated in the accompanying drawing, of which

FIG. 1 is a diagram used in explaining the principle of the invention;

FIG. 2 is a longitudinal sectional view of a horn-reflector antenna embodying the invention;

FIG. 3 is a detailed view to a larger scale of a few of the plates forming the reflector of FIG. 2;

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FIG. 4 is a side view of one of the plates shown in FIG. 3; and

FIG. 5 is a view of an alternative arrangement of the reflector plates.

FIG. 1 shows diagrammatically a sectional view of a reflector 6 oriented at an angle of 45 degrees to the direction of incident electromagnetic radiation indicated by the arrow 7. It is assumed that this radiation includes both longer and shorter waves. The surface of the reflector 6 is constituted by a series of steps or V-shaped grooves such as 8. Each of these steps 8 has a side 9 facing the radiation 7. The transverse dimensions of each of the steps 8 are not more than $\frac{1}{4}$, and preferably less than $\frac{1}{16}$, of the length of the longer incident waves. If the steps 8 are small enough, the longer waves will be reflected in the direction of the arrow 11, substantially as if the surface of the reflector 6 were smooth. However, the smaller the steps, the smaller will be the energy loss due to reflection. But the width of each of the sides 9 is at least equal to the length of the shorter incident waves. Therefore, the shorter waves are reflected back in the direction from which they came, as indicated by the arrow 12. Thus, the incident radiation has been separated on the basis of wavelength.

FIG. 2 shows an example of how this principle of selectivity may be applied to a microwave antenna designed to survive a nuclear explosion in the near vicinity. The antenna comprises a tapered horn 13 and a reflector 14 which closes the larger end except for an opening 16 on one side through which the incoming radiation may enter in the direction indicated by the arrow 17. The horn 13 and the reflector 14, except for the opening 16, are embedded in reinforced concrete 18 for greater strength. A coaxial feed cable 19 is connected to the throat of the horn 13 by a section of wave guide 20 filled by a suitable high-temperature dielectric plug 21. The inner conductor 22 of the cable 19 extends into the plug 21 to form a probe 23 which is thus protected from the excessive heat and pressure existing in the horn 13 immediately following a nuclear blast.

The reflector 14 is a section of a paraboloid of revolution with its axis parallel to the arrow 17 and its focal point at the throat of the horn 13. If the reflector 14 were smooth, the thermal radiation from a nearby nuclear blast would be concentrated on the plug 21 and vaporize it, together with the probe 23. However, the surface of the reflector 14 is made in the form of a series of steps or grooves. These steps approximate the parabolic curve 24-24' in FIG. 2, but are too small to be shown in detail. An enlarged view of four of the steps is shown in FIG. 3. These are formed by stacking steel plates 26 one upon another, with each set back from the edge of the next by a distance b dependent upon the curve 24-24'. The major faces of the plates 26 are parallel to the axis of the paraboloid. The front edge 25 of each plate has the same contour, corresponding to the parabola which characterizes the shape of the reflector 14. FIG. 4 is a plan view of a typical plate 26. The thickness c of each plate 26 is not more than $\frac{1}{4}$, and preferably less than $\frac{1}{16}$, of wavelength at the operating frequency. For a signal frequency of four kilomegacycles, a thickness of $\frac{3}{16}$ of an inch is satisfactory. As shown in FIG. 3, the front edge 25 of each plate 26 faces the arrow 17.

When the steps in the surface of the reflector 14 are this small, the direction of the reflection of the signal waves is substantially the same as if the steps were not present. Therefore, the signal waves are focused at the throat of the horn 13, propagated along the guide 20, and picked up by the probe 23. However, thermal radiation from a nuclear explosion falls in a wavelength range which is very short compared to the width of the edges 25 of the

plates 26. Therefore, any such thermal radiation entering the opening 16 in the horn 13 is reflected by the edges 25 back through the opening 16 without damaging the plug 21 or the probe 23.

FIG. 5 shows an alternative arrangement of the plates forming the reflector 14. The major faces of the plates 28 are perpendicular to the axis of the paraboloid. The plates 28 are placed side by side and each is raised with respect to the next one so that the upper portion 29 of its front side faces the incident thermal radiation and reflects it. The width e of the exposed portion 29 depends upon the curve 24—24'. in the present example, the thickness d of each plate 28 may be $\frac{1}{4}$ of an inch. The side view of a plate 28 will be about the same as FIG. 4. However, each of these plates will have a circular contour which differs slightly in radius from plate to plate.

To improve reflection of the unwanted thermal radiation, the edges 27 of the plates 26 and the portions 29 of the plates 28 are preferably highly polished or plated with chrome or some other appropriate metal.

It is to be understood that the above-described arrangement is only illustrative of the application of the principles of the invention. Numerous other arrangements may be devised by those skilled in the art without departing from the spirit and scope of the invention.

What is claimed is:

1. An antenna reflector with a surface having a series of adjacent, V-shaped grooves therein, each of the grooves having a side facing in the direction of incident electromagnetic waves, the sides of the grooves having widths less than one-quarter of the wavelength of the waves, and the edges of the grooves defining a surface adapted to focus the waves.

2. An antenna reflector having a curved surface adapted to focus a first incident electromagnetic wave at a focal point outside of the path of the incident wave, the surface of the reflector having a series of adjacent steps each having a side facing in the direction of the incident wave,

and the transverse dimensions of each step being less than a quarter of the wavelength λ of the first wave, whereby other electromagnetic waves of wavelength shorter than $\lambda/4$ incident from the same direction as the first are directed away from the focal point.

3. In an antenna system, a solid, curved reflector adapted to be illuminated by incoming electromagnetic radiation of different wavelengths incident from the same direction, the surface of the reflector being shaped and oriented to concentrate the radiation of longer wavelength in a focal area outside of the path of the incoming radiation, the surface having a series of steps with transverse dimensions less than one-quarter of the length of the waves of the radiation of longer wavelength, and each of the steps having a side facing the incoming radiation, whereby the radiation of shorter wavelength is reflected back in the direction from which it arrived.

4. An antenna system comprising a horn and a reflector closing the larger end thereof, the horn having an aperture in a side thereof near the reflector, the reflector being adapted to receive electromagnetic waves entering the horn through the aperture and bring the waves to a focus near the small end of the horn, the surface of the reflector having adjacent, V-shaped grooves therein, the transverse dimensions of the grooves being equal to less than a quarter of the wavelength of the waves, and each of the grooves having a side facing in the direction of the incoming waves.

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