Feb. 16, 1965 B. I. SMALL ETAL 3,169,311

METHOD OF MAKING A DISH-SHAPED ANTENNA REFLECTOR

Filed June 28, 1961

Fig. 1

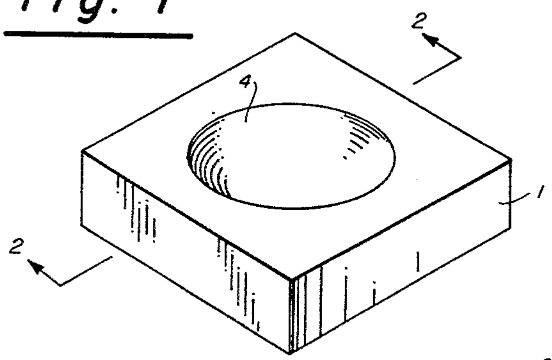


Fig. 2

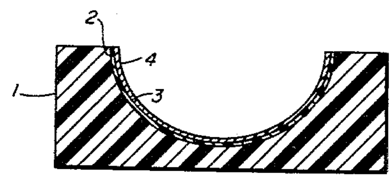


Fig. 3

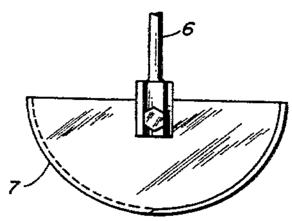
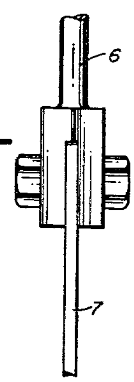


Fig. 4



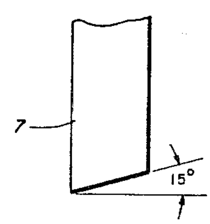
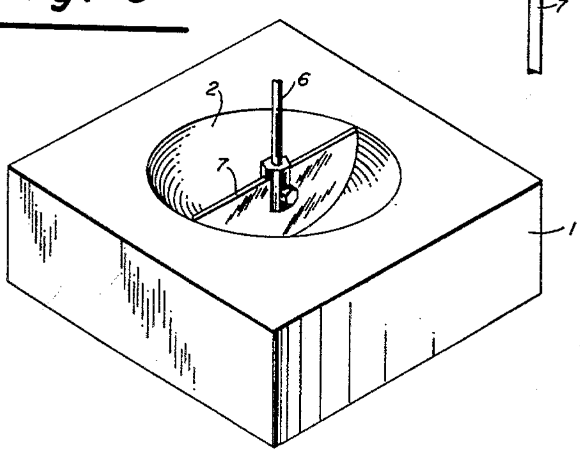


Fig. 5

Fig. 6



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METHOD OF MAKING A DISH-SHAPED ANTENNA REFLECTOR

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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.

The present invention relates to dish-shaped antennas such as the common parabolic antennas and, more in particular, to their reflector portions and to fabrication methods for the reflectors.

The principles of the invention will be considered with particular regard to parabolic antenna reflectors, although it will be apparent to those skilled in the art that these principles apply equally well to other reflector curvatures or to sections cut from parabolas or other curvatures.

The fabrication of parabolic reflectors for test or other purposes is recognized as being a most exacting, time-consuming task requiring extensive periods of time for calculations and construction, as well as for final evaluations in which the calculated and predicted antenna patterns and other operational factors are checked. Even so, the first operational checks often reveal inaccuracies which then require substantial and expensive modifications, although it is true that these inaccuracies result more from peculiar environmental factors than from miscalculations. Whatever the cause, it seems that present fabrication practices generally are viewed as a "cut and try" procedure in which the obvious heavy expense and wasted time appear to be accepted as a necessary evil. A "cut-and-try" approach of this nature is particularly objectionable in the fabrication of large, dish antennas where the expense increases with size.

A further difficulty appears to be the absence of any procedure for fabricating large or small dish antennas without employing what amounts to laboratory procedures in which special facilities are provided and skilled personnel employed in an effort to assure maximum accuracy. As a result, the cost of the production units is high and, of even greater importance, the units cannot readily be provided for users that lack these special facilities. For example, remote field stations or amateurs in the field have had no way of fabricating their own units so as to avoid the usual heavy procurement expense and delays.

It is therefore an object of this present invention to provide a readily-available, easily-accomplished, low-cost, expeditious manner of producing parabolic antennas and the like.

Another general object is to provide a method of testing such antennas in a relatively low-cost, expeditious manner; this general object featuring the provision of a reduced-scale, foam plastic model or prototype of the full sized dish-shaped antenna.

A further object related to the last-mentioned one is to provide a method of rapidly, accurately and inexpensively forming the curvature of a dish-shaped antenna reflector, and, more specifically, of forming the curvature of a plastic reflector.

Still another object is the provision of an antenna reflector formed of particular, readily-workable materials that can be easily shaped and combined to provide a strong, durable and accurate reflector curvature.

Another object is to provide a method of machining particular materials to provide an arcuately-shaped strong, durable and accurate reflector curvature.

Another object is to provide a method of machining particular materials to provide an accurately-shaped and protected reflector curvature for a dish-shaped antenna.

Another object is to provide a "built-up" antenna reflector in which the reflector portion is formed by machining and coating operations and, as a correlative object, a "built-up" reflector in which the machining operations can be accomplished by power-driven tools.

A further important object is to provide a novel method of testing the design capabilities of large, dish-shaped antennas without the need for constructing dimensionally-accurate antenna prototypes.

Other objects of the invention will become readily apparent in the detailed description which is to follow.

The invention contemplates the testing of antennas by providing easily-produced, reduced-scale models which can be tested in a contemplated environment by employing radiations of a correspondingly reduced wavelength. It further contemplates the fabrication of antenna production units for actual field use as contrasted with test units. Most suitably, the antennas are fabricated from blocks of easily-worked material such as foam plastic, these blocks being initially machined to provide a desired reflector curvature which then is built-up by the application of a plaster-like coating that can be accurately reshaped, preferably, while in a partially-set condition. The reflective surface may be provided by applying an outer coating of a conductive metal.

A number of other significant features will become readily apparent in the ensuing description and claims.

The invention is illustrated in the accompanying drawings of which

FIG. 1 is a perspective view of a completed parabolic antenna reflector constructed in accordance with the principles of the invention;

FIG. 2 is a section along lines 2—2 of FIG. 1;

FIG. 3 and FIG. 4 are side and end elevations, respectively, of a tool used in forming the reflector;

FIG. 5 is an enlarged fragmentary end view of the tool's cutting edge; and

FIG. 6 is a perspective illustrating the manner in which the reflector curvature is formed.

Referring to FIGS. 1 and 2, it may be noted that the finished reflector of the present invention is formed of a plastic block 1 having an appropriately-curved reflector surface 2 coated with a protective plastic layer 3 and an outer conductive-metal, reflective surface 4. For reasons which will become evident, block 1 preferably is formed of a light, strong and relatively hard synthetic resin or plastic which is capable of being easily machined or otherwise cut to shape. To obtain a desired lightness and also to increase machinability, an expanded or foamed plastic or synthetic resin may be used, one particularly appropriate example being the expanded, cellular polystyrene known as Styrofoam, commercially produced by the Dow

Chemical Company. Other expanded plastics or resins which may be used are the polyurethane foams, foamed phenolics and the like.

Protective coating 3 of the reflector may be formed of any settable plastic material capable of being applied in a viscous or semi-fluid state so as to harden or set into a solid protective coating subsequent to application. Excellent results are obtained by the use of ordinary plaster or gypsum plasters such as plaster of Paris, and, if desired, ordinary plaster retarders may be added to slow the setting time. Plaster has been found appropriate because it penetratively provides not only desirable mechanical strength to resist denting or other physical damage, but also because of its excellent resistance to heat and to solvents such as may be used in the subsequently applied metal paint spray. Reflective metal coating 4 is provided by any conductive metal such as aluminum, silver, zinc, brass, etc. The coating may be applied by any hot molten metalizing technique or simply in the form of a metal spray or paint. When the metal is applied in a hot state, the advisability of using a protective, heat-resistant plaster or the like becomes apparent.

The method by which the antenna reflector illustrated in FIG. 1 is fabricated provides one of the important features of the invention since, as will be noted, it is unusually simple and fast particularly as compared with the time consuming and exacting procedures previously employed. As has been indicated, the method includes simply the steps of machining plastic block 1, coating the machined portion with plaster layer 3 and then applying a metal spray to the plaster layer, although these steps should be performed in particular manners to assure final accuracy and smoothness of the reflective surface. For example, the machining of the plastic block is greatly facilitated by the use of a special tool illustrated in FIGS. 3, 4, and 5, this tool being formed of a shank portion 6 and a semicircular cutting portion 7 securely carried by the shank. Most suitably, portion 6 is adapted to fit into a drill press or other power unit which, when driven, rotatably advances cutting portion 7 into the block to drillably machine a surface corresponding in curvature to the cutting edge curvature. Portion 7 may be formed of one-half inch flat aluminum and its cutting edge, as illustrated in FIG. 5, may be provided with a rake angle of about 15 degrees, although the rake of this angle will depend somewhat on the materials used and other known factors.

Most important, the base or cutting portion 7 has a cutting edge which is arcuately shaped in precise conformity with the curvature desired for the finished antenna reflector, and, to achieve accuracy of tool shape it may be found advantageous to employ a template (not shown) in its formation. Utilizing a tool having such an arcuately-formed curvature, the drilling of the block initially shapes the plastic in the desired manner. However, since the finished reflector is formed of built-up layers, the initial drilling step is continued until the recess is approximately ⅛" deeper than the desired reflector curvature.

Following the drilling, the formed recess is coated with the wet plaster 3 and, most suitably, this wet plaster is smeared on to provide a layer of about ¼" thickness which, of course, leaves a shallower recess than that ultimately desired. Next, the plaster is permitted to partially set and the drilling tool again employed to remove the excess ⅛" of the plaster thickness. Finally, after the plaster has dried and completely set, metal coating 4 is sprayed on, although, of course, this coating can be applied in various known manners other than as a metal spray.

The finished reflector is an accurately-formed, shock-resistant unit which obviously is far easier and less expensive to produce than the usual metal reflectors. Its accuracy is assured by the use of the special tool which may be employed after any of the processing steps to check accuracy during fabrication. The durability and strength is inherent in the hard plastic coating which additionally protects the underlying fabric from the heat of the metal application and from solvents present in the metal spray or in the environment of the reflector itself. Other real advantages are found in the light-weight obtained by the use of the foam plastic and from the fabrication ease attributable to all of the materials employed.

Reflectors formed in this manner may be employed both for test purposes or as production units. Their particular test advantages are most apparent in connection with the testing of large-size dish antennas where, as previously discussed, the expense involved in modification of the large prototypes is excessive. To avoid such an expense, reduced-scale prototypes may be easily formed in the manner already described. Most suitably, these prototypes are reduced in scale to a size compatible with model work at "X" band frequencies, i.e., 9375 megacycles, or, in other words, the scale of the model is selected so as to present a reflective curvature to "X" band frequencies which will provide a realistic and reliable simulation of the antenna pattern deisred for the larger field use model. The reduced scale models then are tested at the "X" band frequencies so that needed modifications which become apparent in the test can be made without involving the expense of the larger models. If need be other modified models can be built and tested since the expense of these models is so minimized as to present little difficulty. As a result, very accurate curvatures can be obtained at a minimum cost.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. A method of forming a dish-shaped antenna reflector having a predetermined concave reflector curvature, comprising shaping a plastic material for providing a concave surface curvature roughly corresponding to but deeper than said predetermined reflector curvature, building-up said concavely shaped surface to a curvature shallower than said predetermined reflector curvature by applying thereto a coating of a settable plasticized material, permitting said material to partially set, shaping said partially set material for providing said predetermined reflector curvature, and metalizing said finally shaped surface.

2. The method of claim 1 wherein said plastic material is a foam plastic, and said settable plasticized material is a quick-setting plaster.

3. A method of forming a dish-shaped antenna reflector having a predetermined concave reflector curvature comprising drillably grinding a light-weight cellular plastic material for providing a concave surface curvature roughly corresponding to said reflector curvature, applying to said shaped curvature a coating of a settable plasticized material, permitting said material to partially set, drillably grinding said partially set material for providing said predetermined reflector curvature, and metalizing said finally shaped surface.

4. A method of forming a dish-shaped antenna reflector having a predetermined concave reflector curvature, comprising drillably grinding a foam plastic material for providing a concave surface curvature roughly corresponding to but deeper than said predetermined reflector curvature, building-up said concave shaped surface to a curvature shallower than said predetermined reflector curvature by applying thereto a coating of a wet settable plasticized material, permitting said plasticized material to partially set, drillably grinding said partially set material for providing said predetermined reflector curvature, and metalizing said finally shaped surface.

5. A method of forming a shaped antenna reflector having a predetermined concave reflector curvature, comprising providing a cutting tool having an arcuate cutting edge shaped in precise conformity with said predeter-

mined reflector curvature, feeding said tool into a surface of a lightweight cellular plastic block for forming a surface curvature corresponding to said reflector curvature, applying to said formed curvature a coating of a settable plasticized material, permitting said applied material to partially set, again feeding said tool into said partially-set material for providing said reflector curvature, and metalizing said finally shaped surface.

6. The method of claim 5 wherein said cellular plastic material is a foam plastic, and said settable plasticized material is a quick-setting plaster.

7. The method of claim 5 wherein said tool is rotatably fed into said plastic and said plasticized material.

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