

April 10, 1962

B. SOKOL
RADAR REFLECTOR

3,029,433

Filed June 13, 1958

2 Sheets-Sheet 1

FIG. 1

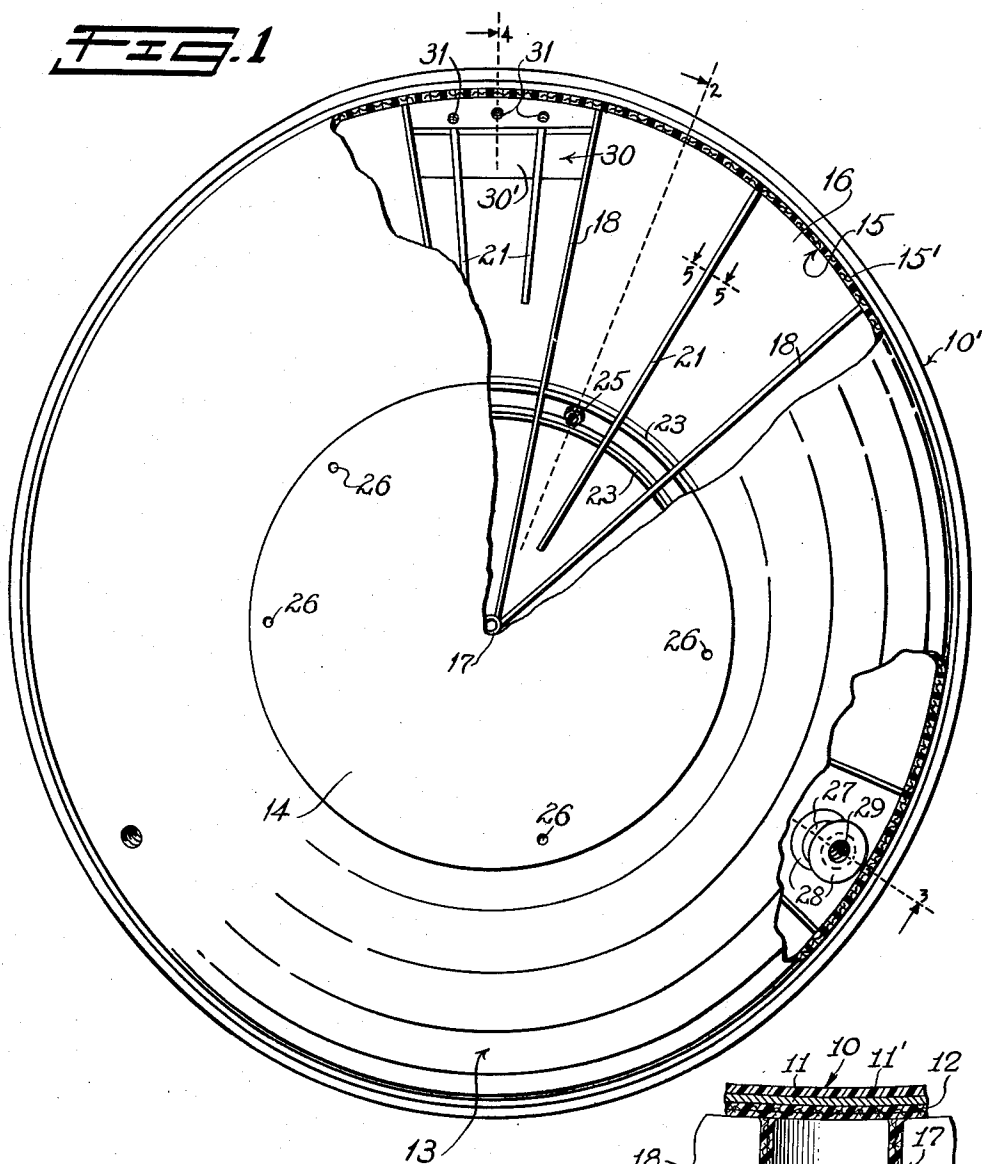
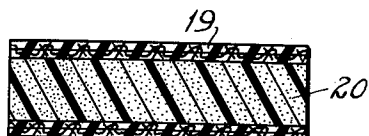
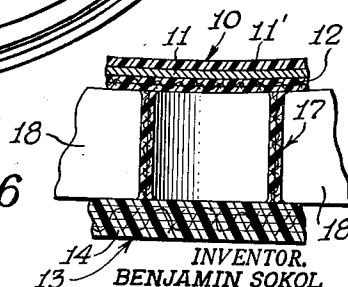


FIG. 5

FIG. 6



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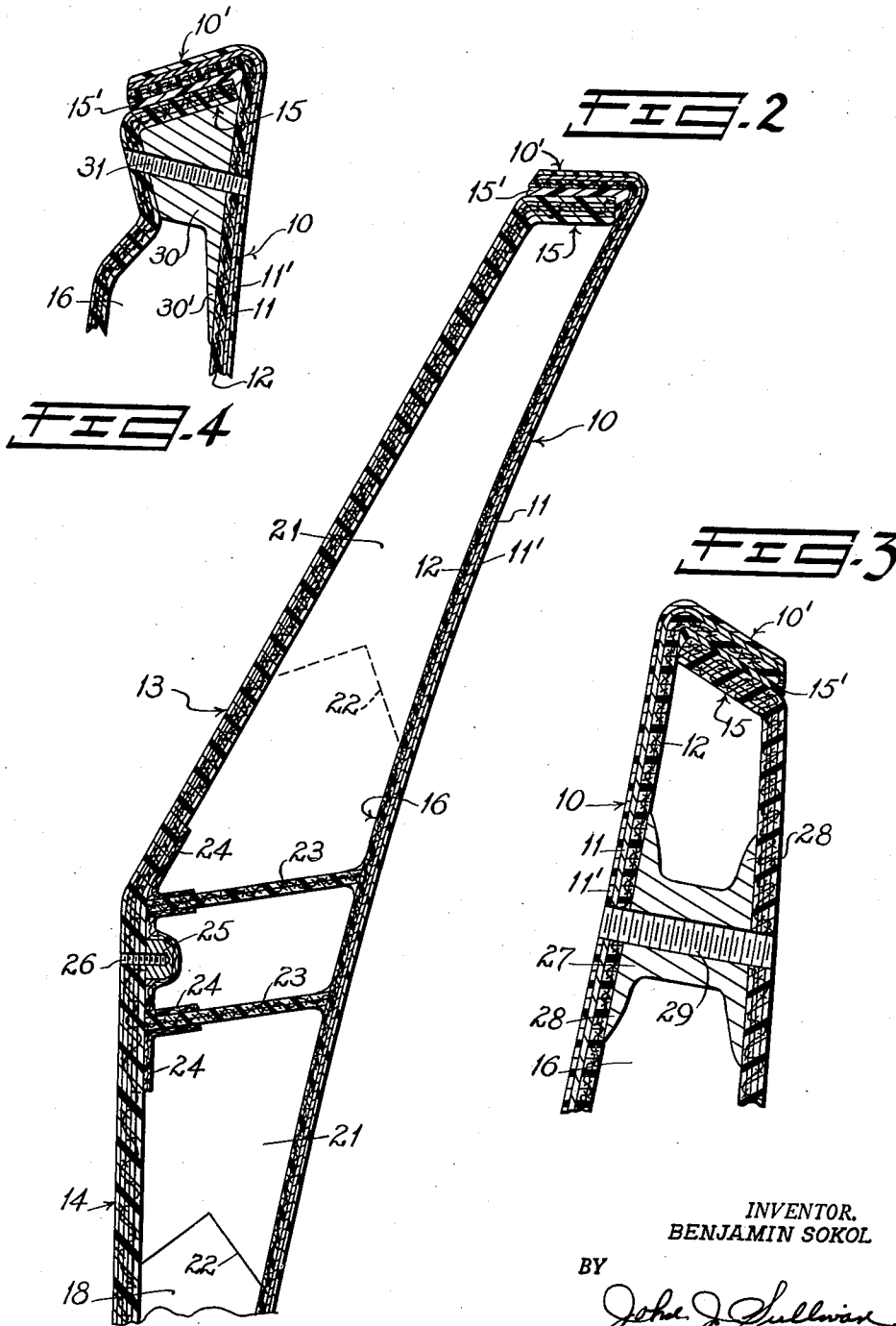
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RADAR REFLECTOR

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3 Claims. (Cl. 343-912)

This invention relates to radar reflectors and more particularly to a radar reflector assembly wherein the components thereof including the mounting structure therefor are bonded one to the other to form a unitary structural member.

Among other things, the present invention contemplates an improved radar reflector to designed and constructed that manufacturing problems heretofore involved are eliminated and greater accuracy in the formation thereof is obtained. At the same time, the ultimate reflector assembly has greater strength, rigidity and wear-resistant qualities than those heretofore.

A reflector element per se to be efficient in operation must be formed to close tolerances and is usually paraboloidal or a paraboloidal segment in shape. Not only have difficult and complex manufacturing processes been employed in the forming of the reflector element to the required accuracy, but once formed, equally difficult and complex methods and means have been resorted to in mounting it for operation on its supporting structure lest it be distorted, damaged, etc. In thus mounting the reflector, some rigidity has also been lost in the final assembly.

Moreover, in service these prior reflector assemblies have left much to be desired in durability. Being fully exposed to weather and the elements, the reflector element of these assemblies is prone to deteriorate and corrode, is rendered inoperative by the formation of ice and snow thereon, and is permanently and irreparably damaged when struck and/or punctured by debris, missiles, etc.

For example, snow and ice have been a particular nemesis to the proper operation of such reflectors. When it collects or forms on the face of the reflector element or screen, it often prevents the reception and transmission of signals. These prior reflectors are especially prone to such ice formations since the face thereof has heretofore been perforate or mesh, and snow and ice accumulating in and filling the interstices is not easily removed. At the same time the construction of the mounting and supporting structure for the reflector screen of these prior assemblies has comprised a network of structural members most conducive to ice formation which can and often does become unduly heavy. In such case the entire reflector assembly becomes unbalanced and the required oscillatory movement thereof is adversely affected. Hence, the efficiency of the reflector assembly is substantially impaired if not destroyed.

Under such circumstances, removal of the objectionable accumulation is a slow and painstaking job due to the relative fragility of the reflector assembly. Every precaution is taken to insure that the reflector element or screen is not damaged or distorted, nor the mounting and supporting apparatus deflected or otherwise altered to dispose the screen in any position other than that for which it was designed at every given instance during its oscillatory movement.

To overcome the above and other shortcomings of existing radar reflector assemblies, the present invention has in view the construction or fabrication of a reflector element and mounting apparatus therefor by which greater strength, rigidity and durability is attained. At the same time, the manufacturing process is considerably simplified and the ultimate assembly permanently formed to a

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greater degree of accuracy for finer reception and broadcast capabilities.

More specifically, it is proposed to form a reflector element to the desired size and shape which comprises a relatively thin, continuous and smooth film or coat of reflective material supported by a plurality of back-up layers of reinforcing material impregnated with synthetic resin secured or bonded thereto. A supporting and mounting attachment, corresponding peripherally in size and shape to the reflector element to thereby matingly receive the reinforced side of the reflector element, is separately formed or molded. This attachment includes structural members of resin impregnated reinforcing material bonded together and cured to form an integral unit. The attachment is thereafter bonded to the reflector element to produce the ultimate assembly.

It has been found that a reflector assembly in accordance with the teachings of this invention may be more readily constructed to greater accuracy at a fraction of the cost heretofore. Moreover, it is more durable in that it has better weather-resistant and non-corrosion properties and permits substantially more abuse without deflection and/or distortion, as when it becomes necessary to remove snow and ice accumulations. Due to the smooth and continuous external surfaces of both the present reflector element and its supporting and mounting attachment such ice accumulations are not readily formed. However, when formed under severe conditions, adhesion is not as strong as in earlier assemblies and the removal of the ice is comparatively easy.

In addition and in contrast to prior reflectors, damage such as punctures, dents, etc., occasioned by flying objects, bullets and the like to the present reflector is not irreparable. Due to its particular fabrication, such damage is comparatively easy to repair whereby the reflector may be restored to its original condition with no permanent effect to its operating efficiency in the broadcast and reception of signals.

With the above and other objects in view, as will be apparent, this invention consists in the construction, combination and arrangement of parts all as hereinafter more fully described, claimed and illustrated in the accompanying drawings, wherein:

FIG. 1 is an elevation of the present radar reflector assembly from the rear with parts broken away to show generally the structure by which the reflector element is supported and by which it is to be mounted on associated structure in its ultimate assembly;

FIG. 2 is a transverse section taken along line 2 of FIG. 1 to show substantially one symmetrical half of the reflector assembly and its construction;

FIG. 3 is a section taken along line 3 of FIG. 1 to show one of the mounting attachments or fittings of the assembly for the connection of associated structure thereto;

FIG. 4 is a section taken along line 4 of FIG. 1 to show another such attachment or fitting;

Fig. 5 is a section taken along line 5-5 of FIG. 1 to show one preferred form of construction of the internal structural members or ribs of the reflector assembly; and

FIG. 6 is a transverse section taken at the center of the reflector assembly to show the structure of the hub and connection of the several ribs thereto.

With particular reference now had to the drawings, 10 designates a reflector element molded or formed substantially to paraboloidal shape with the peripheral edge thereof turned in the direction of the convex side of the element to form a defining flange 10'. This reflector element 10 comprises a relatively thin film or spray 11 of reflective material such as aluminum, steel etc., covered with a protective coat or layer 11' of clear synthetic resin. The film 11 so coated forms the concave surface of the

reflector element 10. One or more layers 12 of reinforcing material such as glass cloth, wire mesh, etc., impregnated with a synthetic resin, preferably epoxy, are bonded to the opposite or convex surface of the reflector element 10.

A mounting and supporting structure 13 is bonded to the convex face of the reflector element 10 adjacent the periphery thereof. This structure or member 13 is substantially an inverted truncated cone in section with a base 14 closing the smaller end thereof. The member or cone 13 is formed or built up in the same manner as the layers 12 already described and terminates in a peripheral flange 15 extending in the direction of the reflector element 10. The diameter of the cone 13 at its larger, open end is substantially equal to that of the reflector element 10 to the end that the outer surface of the peripheral flange 15 thereof substantially abuts the inner surface of the flange 10' on the element 10. These abutting surfaces of the flanges 10' and 15 are bonded one to the other as at 15' whereby a substantially integral assembly is produced having a hollow center portion 16.

At the center of the assembly and disposed between the adjacent faces of the reflector element 10 and cone 13 is a tube 17 formed of reinforcing material impregnated with synthetic resin. The length of the tube 17 is substantially equal to the transverse dimension of the portion or space 16 at this point whereby the opposed ends thereof substantially abut and are bonded to the associated surfaces of element 10 and structure 13, respectively. The tube 17 thereby constitutes the hub of the reflector assembly.

Disposed between the tube or hub 17 and the flange 15 of the supporting structure 13 are a plurality of radial ribs 18 each comprising one or more layers 19 of resin-impregnated reinforcing material and formed to a shape corresponding to the cross-sectional area of the space 16. The opposed edges of each rib 18 thereby abut surfaces of the hub 17, reflector element 10, flange 15 and supporting cone 13 to which they are bonded. If desired, an interlayer 20 of foam material such as cellular cellulose acetate may be sandwiched between layers 19 for added structural integrity.

A plurality of supplemental or auxiliary ribs 21 may be similarly secured to and bonded between the reflector element 10 and supporting cone 13. These auxiliary ribs 21 extend from the flange 15 and are substantially identical to the ribs 18 with the exception that they terminate short of and prior to abutment with the hub 17. At its inner end, a recessed edge 22 in the form of a V is formed or produced in each auxiliary rib 21 to thereby effect a gradual rather than a sharp reduction in backing and supporting strength to the reflector element 10. When employed, these auxiliary ribs 21 are disposed medially between adjacent radial ribs 18.

Additional structural integrity is obtained by a suitable number of transverse ribs 23 the edges of which are interposed between and bonded to adjacent surfaces of the reflector element 10, supporting structure 13, radial ribs 18 and auxiliary ribs 21. Where a substantially uniform distribution of stresses resulting from forces and pressures acting on the opposed sides of the reflector assembly is desired, the transverse ribs 23 may be disposed in substantial end-to-end alignment to form a substantially annular structural member.

In order to supplement the bond or union between the several ribs 18, 21 and 23 and the supporting cone 13 (it has been found that the bond or union between these ribs 18, 21 and 23 and the reflector element 10 is not as critical in this regard), strips 24 of bonding tape may be employed. Each strip or tape 24 comprises reinforcing material saturated with and impregnated by synthetic resin placed in contact with portions of the surfaces of ribs and cone at and adjacent, so as to overlap, each intersection thereof.

Adjacent the center of the supporting cone 13, prefer-

ably at or near the periphery of the base 14 thereof, a plurality of spaced nuts 25 is bonded. An aperture 26 pierces the base 14 adjacent and in alignment with the opening in each nut 25 for the passage therethrough of a screw or bolt (not shown). The reflector assembly is thereby adapted to be connected to associated structure such as the mount of a drive or oscillating mechanism employed in the operation of the reflector assembly in its ultimate installation. Bonding tape 24 may be applied over and around each nut 25 to supplement the bond between the surface of the supporting cone 13 and the adjacent face of the nut (FIG. 2).

An appropriate number of fittings 27 are provided in the reflector assembly, illustrated herein adjacent the peripheral flanged edge 10'—15 thereof. Each fitting 27 comprises a transverse sleeve with enlarged annular end portions 28, disposed between and abutting adjacent surfaces of the reflector element 10 and supporting cone 13. Each fitting is pierced centrally by an internally threaded bore or passage 29. The supporting cone 13 and reflector element 10 are each pierced by holes which aligns one with the other and with the bore 29 to thereby cooperate with suitable attachment means for the connection of associated equipment thereto. Such equipment may, for example, be the horn or arm of a wave guide (not shown) as usually mounted on, to be carried by, the reflector assembly in its ultimate installation.

As an alternate to the fitting 27 where additional attaching strength is required, a substantially larger fitting 30 may be provided by terminating the ribs 18—21 short of the flange 15 or otherwise interrupting such ribs in their length. Each of these fittings 30 comprises an oblong plate, one longitudinal edge of which is curved to correspond to the curvature of the peripheral flange 15 of the supporting cone 13 to the end that it abuts the flange. Like fitting 27 the fitting 30 substantially fills the space 16 in the area of its location with the opposed longitudinal surfaces flush against the inner surfaces of the reflector element 10 and supporting cone 13. If desired, an integral extension 30' may be formed on to project from, the inner or uncurved longitudinal edge of the fitting 30 adjacent the reflector element 10, to thereby create a substantially larger abutting surface for the reflector element 10. Thus, each fitting 30 permits the provision of any number of attachment holes 31 as opposed to the single passage or attachment hole 29. These holes 29 and/or 31 serve the additional purpose of providing convenient attachment means for tools or the like whereby the reflector assembly may be picked up, manipulated and handled when it is not actually installed for operation.

While the preferred fabrication of the entire reflector assembly, save the film 11, nuts 25 and fittings 27 and/or 30 which are metal, is epoxy resin, any synthetic resin may be employed without departing from the scope of the present invention. Moreover, where such resin is reinforced by glass cloth, rovings, wire mesh, etc., as hereinabove described, any reinforcing material may be used for this purpose. As a matter of fact, where maximum rigidity is to be obtained, advantage may be taken of the applicant's disclosure in copending application Serial Number 727,650, filed April 10, 1958.

In the copending application referred to, metal foil is bonded to a laminate of reinforcing material impregnated with a synthetic resin to be disposed adjacent the outermost layers thereof. This construction may be used to advantage in the fabrication of the supporting cone 13 and/or the back-up layers 12 underlying the reflective film 11 of the element 10. Where employed in the reflector element 10 the structural metal foil of the copending application may readily form the reflective film 11 of the element 10 thereby serving a double function.

What is claimed is:

1. A radar reflector assembly comprising a substantially paraboloidal reflector element formed by a convexo-

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concave film of reflective material defined on its convex side by a peripheral flange and backed on its convex surface by at least one layer of reinforcing material impregnated with synthetic resin, a mounting and supporting structure therefor formed by at least one layer of reinforcing material impregnated with synthetic resin and in the shape of a hollow truncated cone having a diameter at its larger end that is less than the diameter of the reflector element, a peripheral flange projecting from said larger end for overlapping association with the flange of the reflector element aforesaid, said cone having radial and concentric ribs extending from its inner surface that terminate in edge surfaces disposed in the plane of the reflector element to thereby abut localized portions thereof, and a bond integrally connecting all said abutting and overlapped portions of the element and cone thus disposed.

2. A radar reflector assembly comprising a substantially paraboloidal reflector element terminating peripherally in a flange disposed in a plane substantially normal to the plane of the edge of said element and backed by at least one layer of reinforcing material impregnated with synthetic resin overlying and secured to its convex surface, a mounting and supporting structure therefor in the form of a hollow truncated cone having internal, laterally projecting discrete ribs formed of at least one layer of reinforcing material impregnated with synthetic resin, the outer edge surfaces of said ribs being contoured to define a plane corresponding to said convex surface, an integral extension on said cone at its larger end disposed with one of its surfaces in a plane substantially parallel to and abutting a surface of the flange aforesaid when concentrically disposed and nested with the reflector element and the outer edge surfaces aforesaid abutting localized areas of said convex surface, and a bond integrally connecting said abutting areas and surfaces.

3. A radar reflector assembly comprising a substantially paraboloidal film of reflective material having a concave face coated with synthetic resin and backed by a sup-

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porting layer, an integral peripheral flange on said film projecting therefrom in opposition to said face, a hollow truncated cone having a diameter at its larger end different from that of said face and adapted to receive the backed face aforesaid in nested relation, an integral flange projecting from said larger end of the cone toward said face when so nested, said film being adapted to overlap and substantially abut in surface to surface contact the flange on the cone, a connection between said flanges, an integral base closing the smaller end of said cone and disposed in axial alignment with and spaced from the film when said cone and film are nested as aforesaid, a hub disposed totally within the space between said film and cone at the center thereof and connected at its opposed ends to the adjacent surfaces of the film and cone, and a plurality of spaced ribs disposed between said hub and flanges and connected thereto and to said supporting layer and said cone, the supporting layer, cone, hub and ribs all being fabricated of multiple layers of reinforcing material impregnated with synthetic resin and all the aforesaid connections comprising integral bonds of the synthetic resin.

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