Nov. 20, 1951 J. W. FITZGERALD 2,575,339

RUBBER DOME FOR UNDERWATER SOUND

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FIG. 5

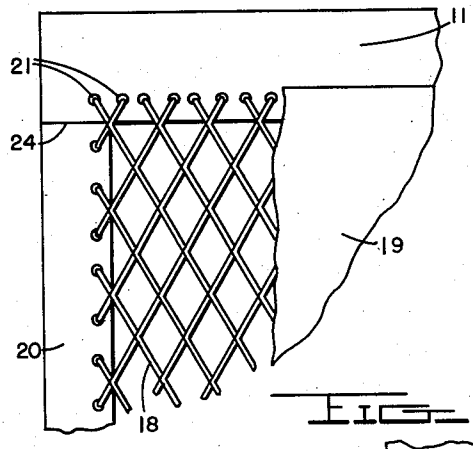


FIG. 1

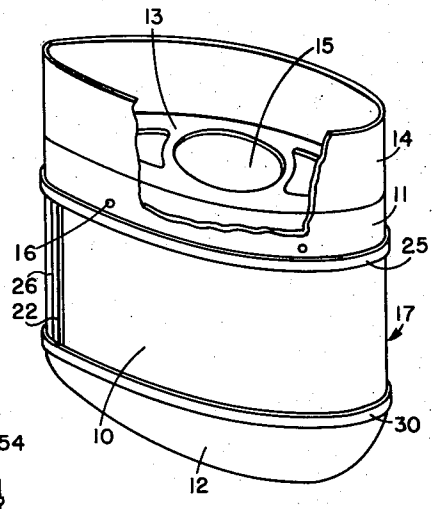


FIG. 2

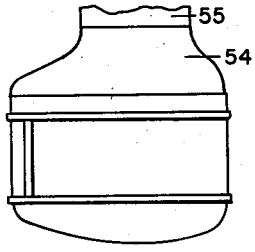


FIG. 8

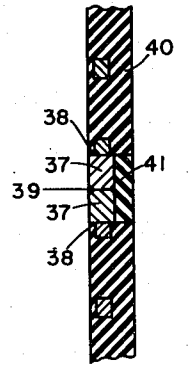
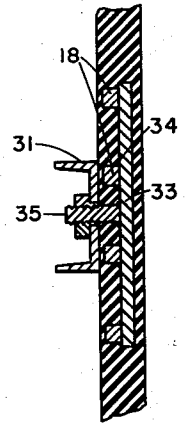


FIG. 6



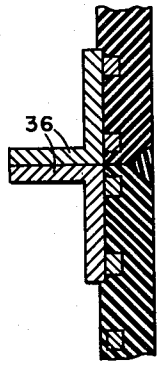


FIG. 7

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FIG. 3

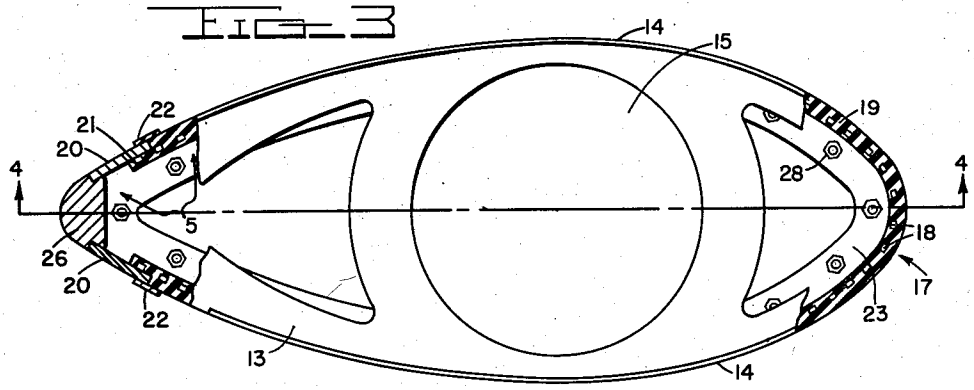

FIG. 4

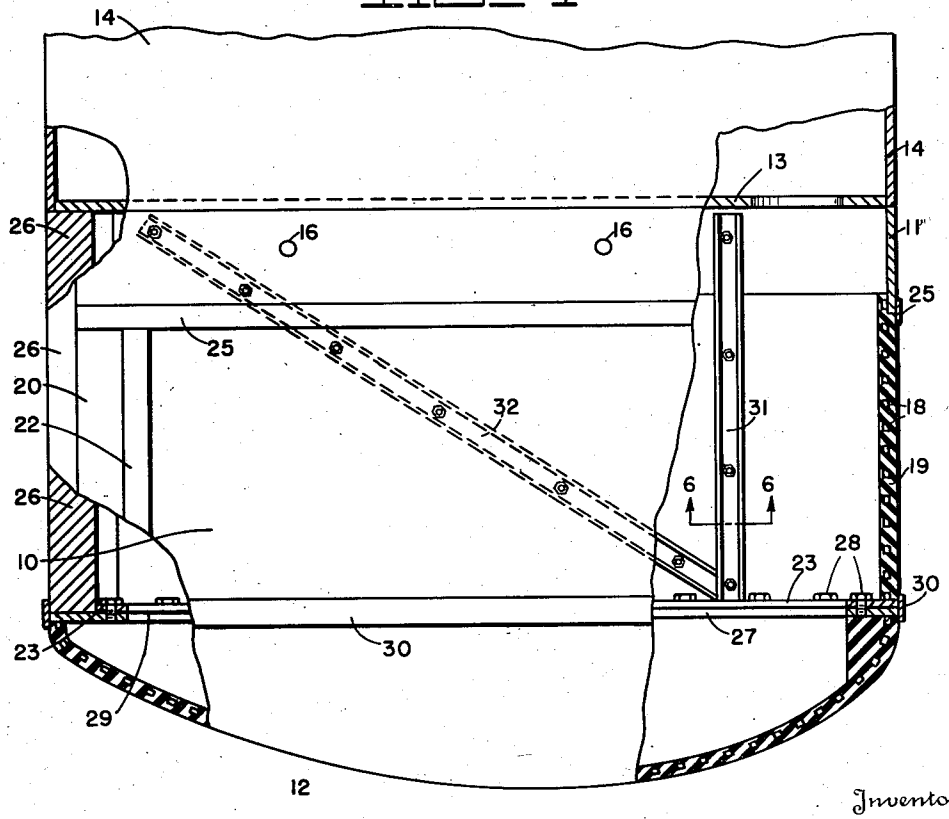

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FIG. 12

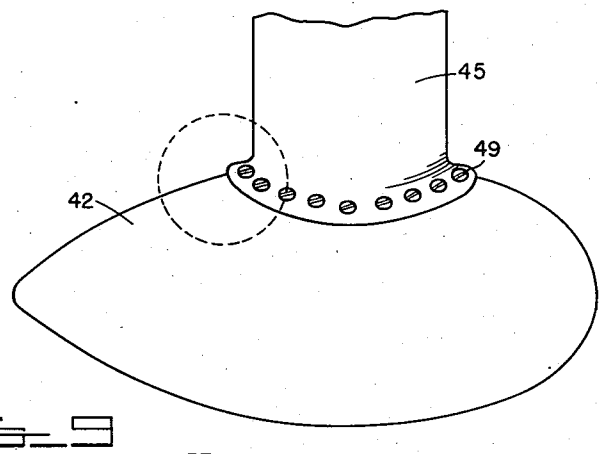

FIG. 9

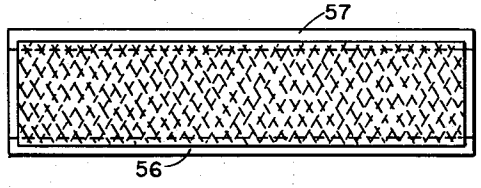

FIG. 10

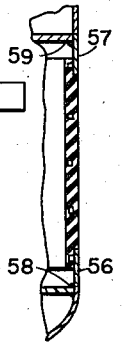

FIG. 13

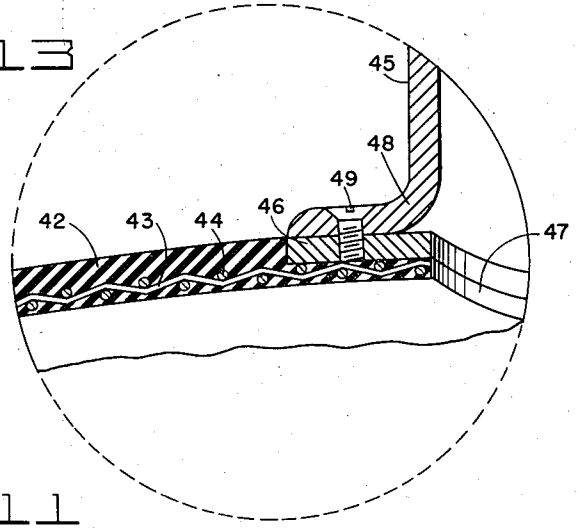

FIG. 11

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Patented Nov. 20, 1951 2,575,339

UNITED STATES PATENT OFFICE

2,575,339

RUBBER DOME FOR UNDERWATER SOUND

James W. Fitzgerald, Alexandria, Va.

Application January 16, 1945, Serial No. 573,089

6 Claims. (Cl. 181—0.51)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

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The present invention relates in general to underwater sound equipment and in particular to underwater streamlined domes or dome structures for housing underwater sound projector-receiver devices.

In underwater sound, echo ranging and listening from ships, any increase in the maximum ship's speed permissible for such operations is of great tactical importance, and to attain the highest speed permissible without objectionable vibration or noise due to turbulence, it is the practice to have the sound emitting and receiving element in a stream lined dome mounted on the bottom of the ship, sometimes to one side of the keel. However, use of the existing type of domes utilizing a thin metal shell as an underwater sound transparent wall member for the dome is met with some loss of range, the beam patterns being often quite badly distorted with reflection lobes appearing nearly as long as the main beam. With a view to improvement the trend has been toward the use of thinner and thinner metal for the walls backed by a form sustaining grid or reticulate frame of stronger metal, but here a mechanical limit is reached before substantial elimination of the above disadvantage is attained. Also problems in maintenance increasing in difficulty with decrease in the thinness of the metal walls present themselves, mainly that of maintaining good joints between the thin sheet metal wall and the form sustaining grid. Here the stresses, highly concentrated at the joints due to necessarily wide spaced small area joints, tends to tear out the joint areas of the thin metal covering.

It is therefore, an object of this invention to provide an improved sound transparent wall structure whereby to make possible the construction of a streamlined underwater sound dome which shall be highly transparent to underwater sound and at the same time resistant to deformation and mechanical failure under the stresses produced by high speed underwater travel and encountered in the pitching and pounding of a high speed boat on which it may be mounted.

Another object is the provision of an underwater dome in which the flexural vibrations set up along the sides of the dome by the propeller noise as well as the transverse vibrations set up at the trailing end by the Van Karman tail effect are not transmitted to the enclosed transducer in magntiude detrimental to the operation of the latter.

A further object is the provision of a joint structure adapted to the joining of sections of the improved sound transparent wall structure to

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each other or to other structural elements without alteration of their physical condition or interference with their sound transparency.

These and other objects are attained through an application of the discovery that the high underwater sound transparency of rubber can be taken advantage of in the construction of an underwater streamlined sound dome when suitably combined with form sustaining means in a manner to preserve the acoustical properties of the rubber substantially undiminished, and at the same time produce a device highly resistant to deformation and mechanical failure.

Various other objects and advantages of the invention will become apparent from a perusal of the following specifications and the drawings accompanying same.

In the drawings:

Figure 1 is a reduced scale perspective view of an assembled dome.

Figure 2 is a reduced scale side elevation of a retractable dome.

Figure 3 is a top plan view partly in section and on a scale larger than that of Figure 1.

Figure 4 is a side elevation partly in section on the line 4—4 of Figure 3.

Figure 5 is a fragmentary detailed view of the portion 5 of Figure 3, with a portion of the rubber covering removed.

Figure 6 is a detailed view of an anchorage for internal structural elements.

Figure 7 shows a modified window-flange joint.

Figure 8 is a further modified window-flange joint.

Figure 9 is a small scale view of a flat, bendable wall panel.

Figure 10 is a fragmentary sectional view showing the panel of Figure 9 installed.

Figure 11 is a modified form of wall structure.

Figures 12 and 13 show a modified form applicable to small domes.

A streamlined underwater dome constructed in accordance with the present invention is shown in the small scale perspective view of Figure 1, and comprises in the main a side wall section 10 with its attaching flange 11 forming an upper extension of the side wall, a bottom wall section 12 and a top plate 13. The side wall portion is continued upwardly in the form of an attaching skirt 14 for attaching the dome to the bottom of the hull of a ship sometimes to one side of the keel, the skirt portion 14 being of sufficient vertical dimension to enable the top rim to be cut to fit the hull contour and permit the side wall section 10 to extend below the keel line. The

opening 15 in the top plate provides entrance for a suitable transducer into the interior of the dome structure. The side wall section and its upper extension comprised of the flange 11 and skirt member 14 are streamlined in horizontal section while the bottom portion 12 is also streamlined in the form of the lower half of a streamlined surface of revolution. The assembled dome is thus streamlined for motion through water with the portion 17 as the front or leading end. In accordance with usual practice the dome is rendered free-flooding by the provision of suitable openings 16 to keep it filled with water from the surrounding body of water. However, as is well understood in the art, other liquids of suitable acoustical qualities may be used.

Where the dome is to be mounted for retraction into a well or recess in a ship's hull, the attaching skirt 14 is replaced by a reducing or taper head as indicated at 54 in Figure 2 for attachment to the usual retractable hollow shaft 55.

Reference to Figures 3 and 5 will explain the improved sound transparent wall structure of the present invention as used in the side and bottom wall sections of the sound dome. Here it will be seen that the sound transparent wall structure comprises a form sustaining, reticulate frame panel 18 of ordinary commercial expanded metal or like structure having a covering 19 of rubber or other suitable rubber-like material in which the reticulate frame member is imbedded. For securing the wall sections in the assembled dome structure suitable metal attaching flanges, such as the flange 20 (Figures 3 and 5) are secured to the margins or edges of the supporting grid panel 18 preferably by welding as indicated at 21. The cover 19 is cured in position preferably under pressure in a mold to effect a secure bond between it and the form-sustaining grid member 18, the pressure acting to force out substantially all of any air previously contained in the rubber. While the main body of the rubber cover is positioned in front along the outside of the grid support, the rubber extends also over the inner side of the grid in an amount sufficient to insure a substantially complete surrounding of the grid elements, as indicated in Figures 3 and 4. Similarly the other edges of the supporting grid member 18 are provided with attaching flanges. For example as indicated in Figures 4 and 5 the top edge is welded to the inner face of the attaching flange 11 in a manner similar to that of the connection between the flange 20 and the side edge of the grid frame. Also as indicated in the lower sectioned portions of Figure 4 the bottom edge of the frame element 18 has welded to it an attaching flange 23 for attachment to the bottom wall section 12. Thus the entire periphery of the supporting grid panel is provided with attaching flanges forming a substantially continuous attaching frame for the grid member. This will be clear upon reference to Figure 5, which shows an inside view of the upper left-hand portion 5 of Figure 3, with the rubber removed. Here it will be seen how the top and side flange members 11 and 20 join to form a continuous attaching frame or flange. Preferably the flanges 11 and 20 are welded together along the seam 24.

By joining the attaching flanges and grid frame as indicated in Figures 3 and 5 with the attaching flanges overlapping the marginal portion of the outer side of the grid member, the rubber covering 19 may be applied to the grid member flush with the outer face of the attaching flange, as shown in Figure 3 so as to place the main body of the covering substance at the front of the grid member, the rubber covering extending through the grid around the grid elements to completely embed the latter. Thus a flush joint is provided where the flanges and the rubber covering substance meet, and to protect these joints from weakening by flexure of the rubber in the immediate vicinity of the joint, cover strips 22 secured to the flanges by seam welding or other suitable means of attaching, extend along the joints in overlapping relation with the rubber covering.

Curing of the rubber covering is effected after assemblage of the supporting grid and connecting flange and preferably under high pressure to bring the body material of the rubber covering into intimate contact with the grid elements and thus effect a strong bond between the grid plate and the rubber covering. The cover strips 22 and 25 are applied after the rubber is cured. As shown in Figures 3 and 4 the side wall panel section 10 constructed as above described extends continuously around the sides and front end of the dome while the rear edges are joined through the attaching plate 20 to a streamlined end post member 26 of suitable structural metal and to which they are secured by seam welding. The bottom wall structure is constructed in a manner similar to that of the side wall member 10 and is provided with a radially inwardly extending attaching flange 27 by which it is attached to the end post 26 and to the lower similarly shaped attaching flange 23 of the side wall member 10. The flanges 27 and 23 may be secured together as indicated by suitable bolts 28 with an intervening gasket 29 for rendering the joint watertight, or in other known manner as by welding in which latter case the welded joint may be of a watertight variety and the gasket dispensed with. To protect the joint between the rubber covering and the flanges 23 and 27, a guard strip 30 is secured around the joint between the flanges, after assembly, by seam welding to the outer edges of the flanges and in overlapping relation with the rubber covering in the immediate vicinity of the joint between the rubber covering and the flanges. To prevent injury to the rubber joint from the heat produced in welding the guard strip 30, the portions of the rubber covering in the neighborhood of the welding operation may be cooled during such welding.

Because of the extension of the attaching flange 23 normal to the wall member 10 which prevents the wall member from being bent into the desired curve from a flat panel form, the rubber covering 19 is cured to the reinforcing grid 18 in the curved form of the finished wall. However, it is to be pointed out that the novel panel structure here disclosed readily lends itself to being formed as a flat panel as shown in Figure 9, with a bottom flange 56 as well as the top flange 57 flat and extending in the plane of the completed wall-panel and later bent to form a vertical wall streamlined in horizontal contour. This enables the new sound-window structure to be used as a replacement for an existing all-metal window panel simply by cutting out the original window panel and installing the replacement by welding in place at the flanges 56 and 57 as indicated in Figure 10 at 58 and 59.

Internal bracing elements in the form of light channel beams 31 and 32 are secured to the inner surfaces of the side walls by means of anchor plates such as the anchor plate 33 shown in Figure 6. As here shown the anchor plate is welded to

the outer side of the grid panel 18 as indicated at 34 and supports a threaded bolt 35 extending through the inner surface of the wall for attachment of the channel elements. These anchor plates with the bolts carried thereby are of course welded to the grid panel before the rubber covering is applied and cured, the dimensions and arrangements of the parts being as shown in Figure 6, such that the rubber covering will substantially completely embed the anchor plate.

In Figure 7 is shown a joint between grid panel sections effected through attaching flanges 36 of angle section. Herein as in the previously described structures the attaching flange is welded to the inner side of the grid panel after which the rubber covering is applied and vulcanized to the plate to effect a strong bond between the rubber and the grid panel. After assemblage of the joint as by spot welding a groove 62 formed in the rubber along the joint either in the molding or by routing out after assemblage of the joint, is closed with a rubber filling 63 vulcanized or cured in place. A further modified joint structure is shown in Figure 8 where the attaching flanges 37 are welded at 38 to the extreme edges of the grid panels. After the grid sections are joined by welding the attaching flanges together as at 39, the rubber covering 40 is applied and cured in place, or the flanges may be welded together after application of the rubber, provided the rubber in the vicinity of the joint is cooled during such welding. After this assembly the rubber filling 41 is applied and cured in place.

A modified form of wall structure as shown in section in Fig. 11 comprises a pair of reinforcing elements 60 and 61 in the form of a mesh or network of flexible, substantially non-stretchable material for example a strong wire mesh, spaced substantially parallel and embedded in a panel of rubber or like material. Such a wall structure has been found to offer a high resistance to bending or other deformation. Because of this quality of rigidity in the finished structure the rubber covering must be cured after formation of the structure preferably in a vulcanizing or curing mold.

Figures 12 and 13 show a modification of the invention for domes of small size, in which the form sustaining grid is comprised of flexible substantially non-stretchable material held taut by a fluid maintained under pressure within the dome. Here the wall of the dome, of rubber like material 42 is cured on to a form-sustaining grid member comprised of network or mesh of strands 43 and 44 of wire, glass fibre or other flexible, non-stretchable material of suitable strength and preferably free of voids or air pockets. Any tendency to deformation of the dome by expansion will be resisted by the substantially non-stretchable strands 43—44 in tension.

The streamline form of the dome is sustained against inwardly directed pressure by maintaining the interior filled with a suitable pressure sustaining liquid preferably seawater. However, other liquids having similar acoustical characteristics as seawater such, for example as castor oil may be used for the pressure sustaining fluid. While in Figure 13 the reinforcing strands are shown related as a simple woven mesh it is to be understood that they may be laid in any relation provided that they are so directed as to resist in tension any outward extension of the walls. To permit ready installation of a suitable hydrophone into the hollow sound dome the dome is provided with a vertically upstanding hollow shaft 45 secured to the upper side of the dome by means of an attaching flange or ring 46 bonded to the body material of the wall of the streamlined dome around the opening 47 in the curing of the rubber covering. The hollow supporting shaft is secured to the attaching ring through a flange 48 and countersunk bolts 49 passing through the flange into threaded engagement with the attaching ring. The shaft 45 which in Figures 12 and 13 is shown discontinued a short distance from the dome, is of indefinite length to be determined according to the particular supporting mechanism used. The shaft acting as a supporting shaft for the dome which may be mounted for retraction in any known or other suitable manner into a well or socket. While certain specific embodiments of the invention have been herein shown and described for the sake of disclosure it is to be understood that the invention is not limited to such specific embodiments but contemplates all such modifications and variations thereof as fall fairly within the scope of the appended claims.

The invention described herein may be manufactured and used by or for the Government of the United States of America for government purposes without the payment of any royalty thereon or therefor.

What is claimed is:

1. An underwater sound dome comprising a main form-sustaining grid panel element constituting vertical front and side walls of an inclosure streamlined in horizontal section, a vertical rear end-post member streamlined in horizontal section to form the rear end portion of a complete horizontal streamlined contour, rear connecting flanges connecting the ends of the side wall portions of the grid element with the end post, a top connecting flange attached to the top marginal portion of the grid element extending along the entire length of said main grid element and therebeyond into connection with the end post and the top of the rear connecting flanges and extending vertically above the grid element and rear connecting flanges, a radial connecting flange attached to the grid element near the bottom of the grid element and extending radially inwardly, a cupped bottom grid wall in the form of the lower half of a streamlined surface of revolution having an axial section contour substantially matching the horizontal section contour of said main grid element, a connecting flange attached near the rim of the cupped grid wall element and extending radially inwardly, said radial flanges being secured together to secure the cupped bottom grid element to the main grid element, a covering of sheet rubber-like material bonded to and embedding the grid elements, a horizontal top plate covering the top of the enclosure formed by the main grid element and top connecting flange, said top plate having an opening therein to provide entrance for a transducer into the interior of the dome, and a housing surrounding the opening in the top plate and extending upwardly for suspending the dome from the bottom of a ship.

2. An underwater sound dome as defined in claim 1 having spaced anchor plates secured to the main grid element and connected by light bracing beams on the inner side of the sheet rubber-like covering.

3. An underwater sound dome as defined in claim 1 in which the housing surrounding the top plate takes the form of a tapered head of general inverted-funnel shape and a hollow shaft extend-

ing upwardly therefrom to permit retractable suspension of the dome from the bottom of a ship.

4. An underwater sound-transparent wall panel for an underwater sound dome comprising in combination a rubber panel having imbedded therein and bonded thereto a reticulated metallic panel and a peripheral metal attaching flange completely framing the reticulated panel and extending uncovered from the edges of the reticulated panel beyond the rubber panel to form an uncoated continuous peripheral attaching frame for the panel, whereby a continuous fluid tight seal for the attaching flange will constitute a continuous peripheral seal for the panel.

5. An underwater sound dome comprising a main form-sustaining grid panel element constituting vertical front and side walls of an enclosure streamlined in horizontal section, a vertical rear end-post member, rear connecting flanges connecting the ends of the side wall portions of the grid element with the end post, a top connecting flange attached to the top marginal portion of the grid element extending along the entire length of said grid element and therebeyond into connection with the end post and the top of the rear connecting flanges, a radial connecting flange attached to the grid element near the bottom of the grid element and extending radially inwardly, a cupped bottom grid wall in the form of the lower half of a streamlined surface of revolution having an axial section contour substantially matching the horizontal section contour of said main grid element, a connecting flange attached near the rim of the cupped grid wall element and extending radially inwardly, said radial flanges being secured together to secure the cupped bottom grid element to the main grid element, and a covering of sheet rubber-like material bonded to and imbedding the grid elements.

6. An underwater sound dome as claimed in claim 4 having an internal bracing element secured to the inner surface of a side of said grid element and extending diagonally from near the top of said end post to near a forward portion of the radial flange of the grid element whereby the dome structure is braced in a plane diagonal to the vertical post and diagonal to the plane of the radial flange.

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