Fig. 4

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INSULATION FOR SPHERICAL TANK SHELLS AND METHOD OF MAKING THE SAME

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8 Claims. (Cl. 154—28)

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This invention relates to the insulation of spherical tank shells and more particularly to the insulation of such shells with material such as corkboard, foam glass, balsa wood, etc.

Such insulating material is usually obtained in the form of flat rectangular slabs several inches thick and the job of lining or covering a spherical tank shell with such material has been troublesome, relatively costly and wasteful of such material, since it has involved much individual trimming and fitting in the field.

Herebefore in constructing linings from this slab-like insulating material, rectangular slabs of such material were laid end to end in rows along great circles emanating from the poles of the spherical shell to be insulated. After the first few rows were put in place, it became necessary to cut a successively larger number of long tapering strips which had to be individually fitted into tapering holes resulting from the inability of the rectangular pieces to fit and cover completely the inner surface of the spherical shell. By the time the lining was completed, a large percentage of the material had been trimmed and individually fitted into place. It will be apparent, therefore, why such a procedure is troublesome, costly and wasteful of insulating material.

I have discovered that such slab-like material can be made to completely cover either surface of a spherical tank shell provided a certain procedure or method is followed, and one object of this invention is to provide an improved method of insulating spherical tank shells and spherical tank shell sections with slab-like insulating material without producing any substantial amount of waste of such material.

Another object is to produce from rectangular slab-like insulating material, an insulating cover for the inner or outer, or both surfaces of a spherical tank shell without substantial waste of such material and without individual trimming of such material in the field.

A further object is to produce in the shop polygonal pieces of slab-like insulating material that can be assembled in the field to substantially completely cover one or both surfaces of a spherical tank shell without any field trimming of such pieces.

A further object is to produce in the shop, triangular pieces of slab-like insulating material that can be assembled in the field to substantially completely cover one or both surfaces of a spherical tank shell without any field trimming of such pieces.

These and other objects which will be apparent to those skilled in this particular art, I attain by means of the method or process described in the specification and set forth in the claims.

An insulating shell capable of serving as a lining or cover for a spherical tank shell can be constructed from relatively small (preferably triangular) pieces of slab-like insulating material provided such pieces are arranged in groups of repeating pattern with each such group having an outline that closely approximates the outline of the figure obtained on a spherical surface by intersecting such surface by radial planes passing through the edges of one face of one of the five regular convex polyhedrons circumscribed by such spherical surface. Such spherical surface must have the same radius as that of the outer or inner surface of the spherical tank shell which is to be covered or lined with such insulating shell, depending upon which surface is to be covered.

It will be apparent that no shell having the form of any of the five regular convex polyhedrons could be used as a satisfactory insulating lining or covering for a spherical tank shell. This is because, if used as an inner lining, the radial distance from the center of each face of the polyhedral shell to the inner surface of the spherical tank shell, and in the case of an outer cover the distance from the edges of each face of the polyhedral shell to such spherical tank shell, would be so great as to make such polyhedral shell valueless for the purpose intended.

Even if such a polyhedral shell had the form of a regular convex icosahedron, it would be unsatisfactory as an insulating lining or cover since the radial distance from the center of each of its 20 faces, in the case of an inner lining, or the edges of such faces in the case of an outer cover, to the surface of the spherical tank shell would be at least equal to 20% of the radius of such spherical tank shell.

Each face, however, of any of the five regular convex polyhedrons can in effect be domed or bulged outwardly and be given abutting triangular facets to form a shell section which so closely approximates a spherical shell section that when such faceted domes in the proper number are arranged in abutting relation to form a complete shell, a satisfactory lining or cover can be produced from slab-like material.

There are but five regular convex polyhedrons. The tetrahedron, hexahedron, octahedron, dodecahedron and icosahedron. Of these five, the icosahedron, with its 20 faces, each of which is
an equilateral triangle, more nearly approaches the shape of a sphere than any of the other four. The dodecahedron, with its 12 pentagonal faces comes next. The tetrahedron, hexahedron and octahedron, which have 4, 6 and 8 faces respectively, are so far removed from the form of a sphere that I prefer to use as a base polyhedron either the icosaehedron or the dodecahedron.

The triangular facets for the outward bulge of each face of a regular convex polyhedron may be obtained as follows:
1. Divide the entire area of one of the faces of the chosen polyhedron into any desired number of triangles.
2. Project the vertices of such triangles radially outward until they intersect a spherical surface circumscribed about such polyhedron.
3. Connect by straight lines the points at which such radial lines intersect such spherical surface.
These straight lines which are chords of great circles on such spherical surface, form the abutting plane triangular facets of one of the outward bulges. The vertices of these facets lie in such spherical surface and the combined area of such facets is substantially that of a spherical triangle obtained by intersecting such spherical surface by radial planes that include the edges of one face of such polyhedron.

By way of example, assume that it is desired to cover the inner surface of a 30 foot internal diameter spherical tank shell with corkboard insulation having a thickness of four inches and a width of 24 inches and that the insulation layout is to be based on a regular convex icosaehedron capable of being circumscribed by such spherical tank shell. I may divide each of the three equal edges of one of the 20 faces of such icosaehedron into nine equal parts. I then connect the ends of the similarly located parts of such edges by straight lines. The single face of the icosaehedron is thus divided into 81 substantially similar triangles, the vertices of which are represented by the points of intersection of such straight lines.

These points of intersection are then projected radially out to a spherical surface which circumscribes such icosaehedron, and such projected points lying in such spherical surface, are then connected by straight lines. These lines form the edges of the 81 triangular facets of one outward bulge or dome-like insulating shell section. Twenty such dome-like sections when arranged in side by side abutting relation, form an insulating lining comprising 1620 triangular pieces that substantially completely cover the inner surface of the spherical tank shell: the total area of these 1620 triangles being 2817 square feet or 99.6% of the area of the inner surface of such spherical tank shell.

These 1620 triangular pieces which form the facets of the outward bulges or dome-like shell sections are quite similar as to size and comprise 1080 oblique triangles divided into six groups and 540 isosceles triangles which are also divided into six groups. Half of the oblique triangular pieces are turned over when they are assembled in repeating patterns on the inner surface of the tank shell so that there are 540 lefts and 540 rights.

If the lining material is so thick that it is necessary to bevel the edges of the triangular pieces, it will be necessary to arrange half of the oblique triangular pieces as lefts and half as rights before they are beveled.

A complete lining of twenty repeating patterns or dome-like sections comprises:

60 A triangular pieces 224″ x 184″ x 184″
60 B triangular pieces 224″ x 204″ x 204″
120 C triangular pieces 204″ x 212″ x 234″
60 D triangular pieces 244″ x 224″ x 224″
120 E triangular pieces 224″ x 234″ x 234″
60 F triangular pieces 224″ x 224″ x 224″
120 G triangular pieces 244″ x 244″ x 244″
240 H triangular pieces 244″ x 244″ x 254″
240 I triangular pieces 244″ x 234″ x 234″
120 J triangular pieces 264″ x 254″ x 254″
240 K triangular pieces 254″ x 254″ x 254″
120 L triangular pieces 264″ x 264″ x 264″

Figure 1 of the drawings is a plan view of a typical group of 81 triangular pieces of flat insulating material arranged in contact with the inner surface of the spherical shell. In this view, the triangular pieces are identified by letter and the oblique triangular pieces are indicated as lefts and rights.

In this figure, the three axes of symmetry are indicated by dot and dash lines. The apparent wide difference in size between triangles adjacent the center and those adjacent the outer edges is due to the fact that the triangular pieces are arranged in contact with the spherical surface and are viewed from a position in front of the center of the dome-like group.

Figure 2 is a plan view of one face of the icosaehedron shell divided into 81 triangles. A number of the points of intersection of the lines forming the triangles have been projected radially outward to the circumscribing spherical surface and then joined by straight lines to form a number of triangles which are identified in accordance with Figure 1.

Figure 3 is a perspective view of a dome-like group of 81 triangular pieces of insulating material as it would appear if the tank shell were removed. In this view, the triangular pieces are identified in accordance with the arrangement of Figure 1. This view contains lines radiating from the center of the spherical shell to the corners of the triangular pieces forming the two near edges of the dome-like section.

Figure 4 is a view of a spherical shell with a partial thereof broken away. Here it is shown that it is lined with triangular pieces of material in accordance with this invention. The opening formed by the broken away part discloses more than two complete dome-like sections of insulating material on the side opposite such opening and also the outline of further dome-like sections indicated by dotted lines.

Figure 5 is a perspective view of a spherical shell covered with triangular pieces of insulating material in accordance with this invention. In this view complete dome-like sections are shown and the outlines of other such sections are indicated by full lines.

The triangular pieces will be cut in the shop from long strips of the material by alternately reversing adjacent triangles to reduce waste. The two end triangles in each strip may be joined into single triangles to further reduce waste.

In some cases, depending on the size, thickness and kind of material from which the triangular pieces are made, and the radius of the spherical shell, it may be desirable to bevel the edges of the triangular pieces to cause them to fit tightly together. Most insulating materials, however, are so pliable that this beveling is not necessary.

After the above triangular pieces have been cut
to the desired dimensions in the shop and divided into 20 bundles each having its proper pieces for a complete pattern or dome-like section, they are ordinarily shipped to the site of the tank and installed in the 20 similar dome-like sections or patterns to form a complete insulating lining for the spherical shell. Such a lining will require no field trimming and can be produced with substantially no waste.

It will be apparent that any of the five regular convex polyhedrons can be used as the basic polyhedron, but I prefer to use either the icosahedron or the dodecahedron since, with these, the group outline (for a given size of spherical shell) within which the triangular pieces are to be arranged is smaller, and therefore fewer triangular pieces for each group are required in order to obtain a satisfactory insulating lining.

When multi-layer linings are desired, the layers are laid one on the other and are preferably secured together by wooden skewer-like pegs.

What I claim is:

1. An insulating lining for a spherical tank shell, comprising triangular pieces of slab-like insulating material arranged in edge abutting relation in dome-like groups of repeating pattern, each such group having a base outline which closely approximates the outline of a figure obtained on a spherical surface by intersecting such surface by radial planes which include the edges of one face of a regular convex polyhedron circumscribed by such spherical surface, such base outlines corresponding in number to the number of faces of such polyhedron.

2. An insulating lining for a spherical tank shell, comprising triangular pieces of slab-like insulating material arranged in edge abutting relation in twenty groups, each of which has an outline approximating the outline of a figure obtained on a spherical surface by intersecting such surface by radial planes which include the edges of one face of a regular convex polyhedron circumscribed by such spherical surface.

3. An insulating lining for a spherical tank shell, comprising triangular pieces of slab-like insulating material arranged in edge abutting relation in twelve groups, each of which has an outline approximating the outline of a figure obtained on a spherical surface by intersecting such surface by radial planes which include the edges of one face of a regular convex polyhedron circumscribed by such spherical surface.

4. A method of covering a substantial part of at least one surface of a spherical tank shell with slab-like insulating material, which comprises forming from such material triangular pieces which are grouped together in side by side abutting relation to form dome-like shell sections, the base of each of which has an outline closely approximating the outline of a figure obtained on a spherical surface by intersecting such surface by radial planes which include the edges of one face of a regular convex polyhedron circumscribed by such spherical surface, arranging such triangular pieces together in side by side abutting relation in contact with the spherical tank shell in recurring outlines of such figure and then securing such pieces in place.

5. A method of covering at least one surface of a spherical tank shell with slab-like insulating material without substantial waste of such material, which comprises forming from such material triangular pieces which can be grouped together in side by side abutting relation to form dome-like shell sections the base of each of which has an outline approximating the figure obtained on a spherical surface by intersecting such surface by radial planes which include the edges of one face of a regular convex polyhedron circumscribed by such spherical surface, grouping such triangular pieces together in side by side abutting relation in contact with the spherical tank shell in recurring outlines of such figure and then securing such pieces in place.

6. A method of covering one surface of a spherical tank shell with slab-like insulating material without substantial waste of such material, which comprises forming from such material triangular pieces which can be grouped together in side by side abutting relation to form dome-like shell sections the base of each of which has an outline approximating the outline of the figure obtained on a spherical surface by intersecting such surface by radial planes which include the edges of one face of a regular convex polyhedron circumscribed by such spherical surface, grouping such triangular pieces together in side by side abutting relation in contact with the spherical tank shell in recurring outlines of such figure and then securing such pieces in place.

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