Feb. 11, 1969 W. C. GREGORY 3,427,139

RIGID STRUCTURE COMPRISED OF HOLLOW, SEALED SPHERES BONDED TOGETHER

Filed June 7, 1967 Sheet 1 of 2

FIG. 1

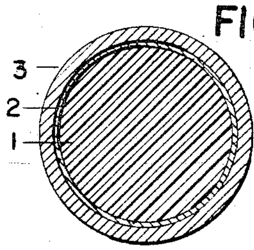

FIG. 2

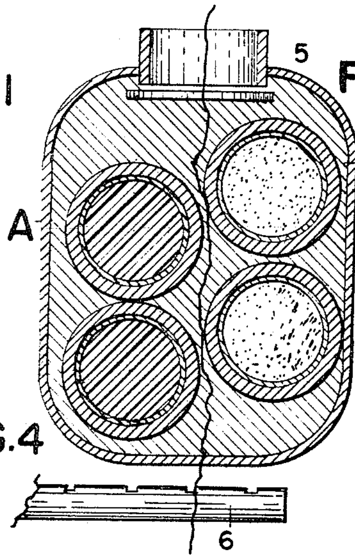

FIG. 3

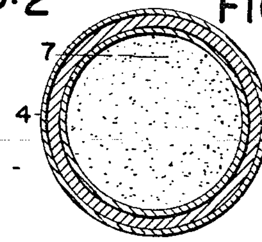

FIG. 4

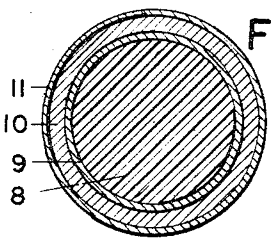

FIG. 5

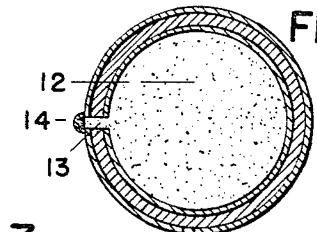

FIG. 7

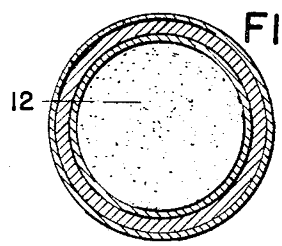

FIG. 8

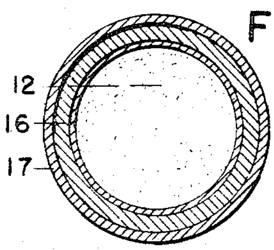

FIG. 6

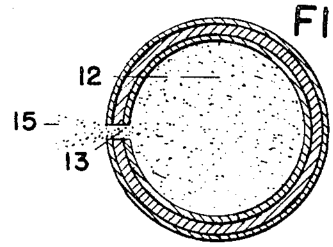

FIG. 9

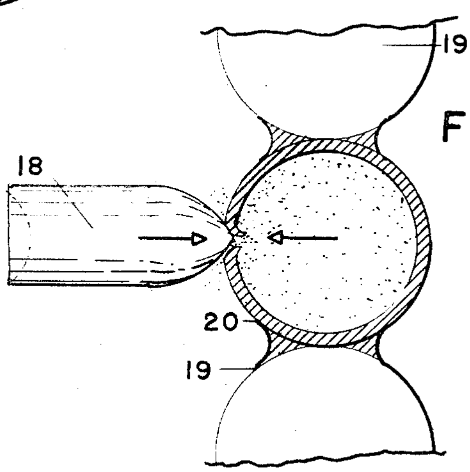

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FIG. 10

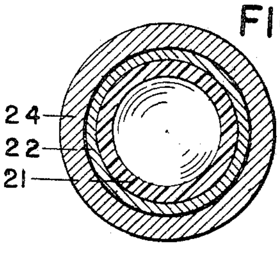


FIG. 11

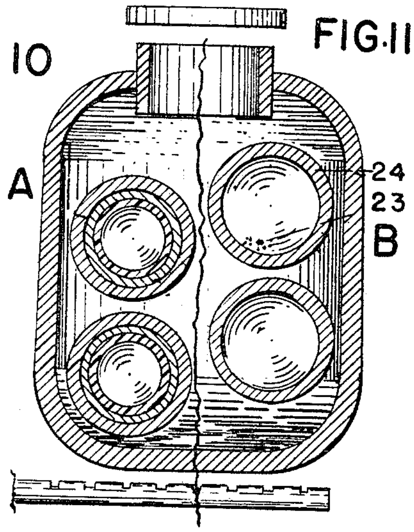


FIG. 12

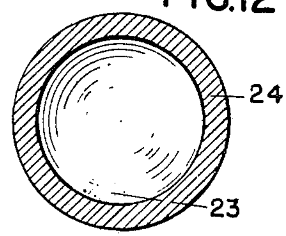


FIG. 13

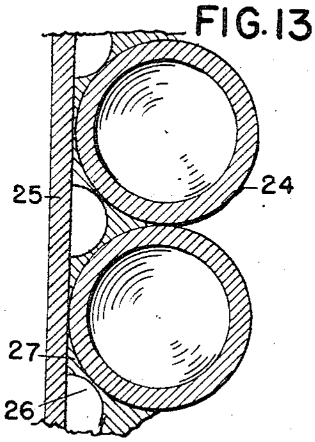


FIG. 14

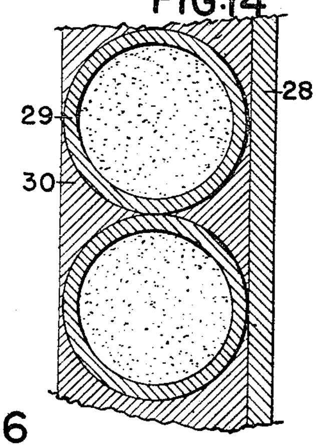
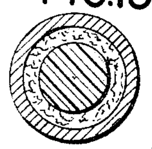


FIG. 15



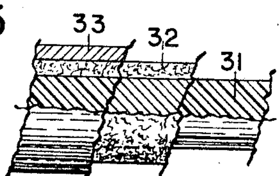


FIG. 16

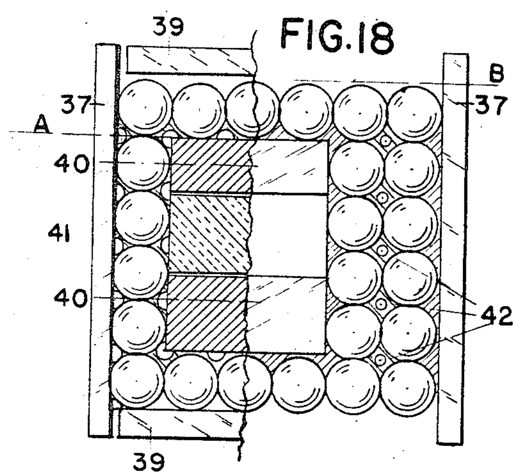


FIG. 18

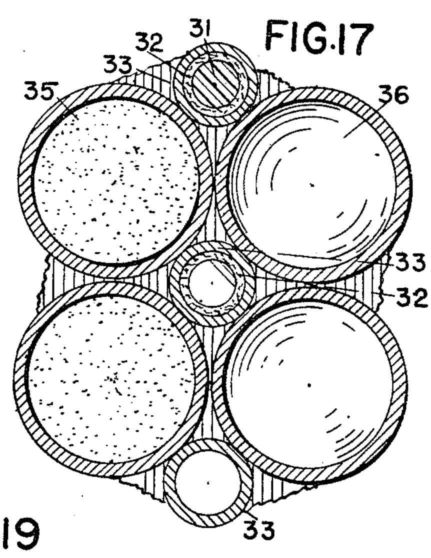


FIG. 17

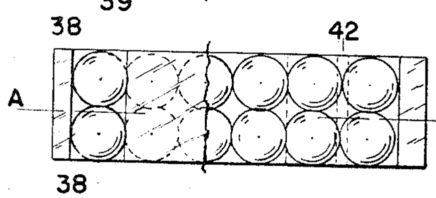


FIG. 19

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RIGID STRUCTURE COMPRISED OF HOLLOW, SEALED SPHERES BONDED TOGETHER

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Continuation-in-part of application Ser. No. 474,118, July 22, 1965. This application June 7, 1967, Ser. No. 657,443
U.S. Cl. 29—183 3 Claims
Int. Cl. E04b 1/74

ABSTRACT OF THE DISCLOSURE

A rigid structure comprised of abutting, hollow, sealed spheres bonded together into a predetermined shape. The interiors of each of the spheres are maintained at a pressure substantially different from atmospheric pressure at ground level. The structure is rigidified by a plurality of sealed tubes disposed in spaces between the spheres and abut the surrounding spheres to reinforce the structure.

This application is a continuation-in-part of pending U.S. patent application Ser. No. 474,118, filed July 22, 1965, now abandoned.

Brief summary of the invention

The invention relates to pressurized spheres which may be manufactured in steps, and the interiors thereof, during the manufacture, are converted from a solid to a gas wherein the sphere will have an internal pressure different than atmospheric pressure at ground level. Further, while the individual pressurized spheres are each capable of independent use, a plurality of the spheres may be combined with hollow, pressurized tubular material to create a rigid, reinforced structure which may be used as insulation, or may be used to suspend machinery.

An object of this invention is to provide hollow spheres adapted for individual or multiple use wherein each of the spheres has a minimum wall thickness of metal and a maximum interior gas pressure.

Another object of this invention is to provide a rigid structure comprising a plurality of substantially equal size, independently sealed, hollow, rigid spheres having greater interior pressure than the exterior atmosphere, wherein said spheres are bonded together, and a plurality of hollow, pressurized tubes are disposed between said spheres whereby the spheres and tubes may be bonded together to complete a reinforced rigid structure.

Brief description of the drawings

FIGURE 1 is a cross-sectional view of a sphere at the initial stage of manufacture.

FIGURE 2 is a cross-sectional view of a heat treating pressure furnace showing a pair of spheres at the time of insertion into the furnace (A, left side of furnace), and a pair of spheres which have been treated in the furnace (B, right side of furnace).

FIGURE 3 is a cross-sectionl view of a pressurized sphere wherein the solid core has been converted to gas.

FIGURE 4 is a modified sphere at the initial stage of manufacture, covered with a bonding layer.

FIGURE 5 is a cross-sectional view of a pressurized sphere at the completion of manufacture, illustrating a vent projecting through the wall of the sphere.

FIGURE 6 is similar to FIGURE 5, except that the gas is being expelled through the vent.

FIGURE 7 is a cross-sectional view of a modified sphere illustrating a different type of interior gas than that illustrated in FIGURE 3.

FIGURE 8 illustrates a sphere similar to FIGURE 3.

FIGURE 9 is a cross-sectional view illustrating a pressurized sphere in combination with other spheres, and adapted to be used as a bullet shield.

FIGURES 10, 11 and 12 illustrate the steps in the manufacture of a modified vacuum sphere structure.

FIGURE 13 is a cross-sectional view illustrating a form of rigid structure produced by a plurality of pressurized spheres.

FIGURE 14 illustrates a modified rigid structure utilizing the spheres as shown in FIGURE 13.

FIGURE 15 is a cross-sectional view of a novel pressurized tubular structure suitable for binding and reinforcing pressurized spheres.

FIGURE 16 is a side view, partially in section, of the tube illustrated in FIGURE 15.

FIGURE 17 is a cross-sectional view of a plurality of pressurized spheres surrounding a plurality of pressurized tubes wherein the tubes and spheres are bonded together to reinforce a rigidified structure.

FIGURE 18 is a view of a rigid structure, partially in section, illustrating the pressurized spheres and pressurized tubes united.

FIGURE 19 is an end view of the structure identified in FIGURE 18.

Description of the preferred embodiments

A single pressurized sphere having a solid core **1** of a material which is capable of oxidizing itself when heated is illustrated in FIGURE 1. This core may be mechanically formed, and may be of any desired shape, but preferably spherical. The core is preferably formed from nitrated cellulose, nitrated glycerine, collodion, or modified black gun powder. It has been found that black gun powder, composed of carbon sulphur, and an oxidizing agent such as potassium nitrate, is most effective. It should be noted that in order to slow down any speed of oxidation, a plasticizer may be incorporated with the gun powder to achieve the desired effect.

The size of the sphere, which appears to be particularly advantageous in the manufacture of rigid structures, is a sphere having a radius of about .45 cc.

The core **1** is then coated with a conductive material **2**, such as graphite, silver, or copper, which may be deposited chemically around the core **1**. After the conductive material **2** completely encases the core, a deposit of structural material **3**, such as iron, chromium, nickel, or their alloys, is preferably electrolytically applied in a barrel plating machine, not shown. Other methods, such as spraying and dipping, may be utilized to achieve a complete coating of the core **1** and conductive material **2**.

After a sphere, such as illustrated in FIGURE 1, has been formed, it is then placed within a heat treating pressure furnace, such as schematically illustrated in FIGURE 2, and by controlled heating, heated to approximately 150° F. The controlled intensified heating of the sphere will convert the core material **1** into a gas, such as is illustrated by the numeral **7** in FIGURE 3. With the core preferably of about .45 cc. radius, the gas **7** which is created from the black gun powder, will equal about 600 atmospheres, or a pressure of about 9000 p.s.i. at 0° C.

When oxidation occurs of the black gun powder core **1**, about 700 calories of black gun powder is liberated. Such amount of heat will generally weaken the structural metal **3**. To overcome the weakening of the structural material **3**, it is preferred that the heated sphere, such as shown in the right-hand side of the furnace in FIGURE 2, be placed in a pressure furnace, not illustrated.

The sphere is then encased in an alloy **4**, such as mercury, Wood's material, lead, silver solder, or the like, so that as the metal in the pressure furnace, illustrated, expands, it will increase in volume, thereby applying pressure to and increasing the entire pressurized sphere.

The sphere illustrated in FIGURE 4 is similar to that illustrated in FIGURE 1, with the exception that after the structural material **10** has been formed on the sphere, a deposit of binder metal having a lower melting point than the structural material 10, such as brass or bronze, is deposited therearound. This binder metal may be applied by spraying, or by chemical precipitation.

The illustrations in FIGURES 5 and 6 show a sphere similar to the sphere in FIGURE 3, which has been pressurized, but there is added thereto a relatively small orifice **13** extending from the interior of the sphere through a wall to the exterior. The gas **12** in FIGURES 5 and 6 is preferably a highly compressed smoke which can be produced from a core of black powder with a sufficient excess of powdered charcoal that only part of it is oxidized upon combustion. The particular structure illustrated in FIGURES 5 and 6 is adapted for use as a tracer whereby when the sphere is struck with a blow, the plastic cap **14** will be disengaged from over the orifice **13**, allowing the smoke **12** to be expelled in a trail **15**, such as is seen in FIGURE 6.

It should be realized that any type of chemical may be added to the core **1**, which will produce a colorable gas or vapor **12**, such as illustrated in FIGURE 7. In the case of the sphere of FIGURE 7, the exterior coating is made relatively thin, so that on impact it will burst, expelling the colored gas **12**.

The sphere illustrated in FIGURE 8 is depicted to represent a sphere to be used as a ball bearing. When such is desired, the coating is preferably of hard chrome. Such a structure as illustrated in FIGURE 8 will produce a strong, lightweight ball bearing.

FIGURES 10 through 14 illustrate a modified embodiment of the pressurized sphere structures in the form of vacuum spheres. In this embodiment, vacuum spheres are prepared by blowing thin walled glass spheres, by any suitable means. The core **21** is then encased within a layer of material, such as magnesium or a magnesium alloy deposited thereon. The deposit of such material is preferably formed by spraying magnesium powder onto the outer surface of the glass sphere **21**.

After the layer **22** is deposited on the sphere, structural metal **24**, of the type previously described, is then applied to the sphere. After the spheres have the structural metal applied, it is preferred that they be placed in a plating barrel containing a zinc cyanide bath, including zinc oxide, sodium cyanide, and sodium hydroxide, and heated to a temperature of between 100° to 125° F. The zinc coated spheres are then rinsed and dried.

The structure as illustrated in FIGURE 10 is then placed in a furnace such as schematically illustrated in FIGURE 11, where, upon heating, the glass spheres **21** will break, exposing the air, whereby the nitrogen and oxygen combine with the magnesium or magnesium alloy, so that the reaction of the nitrogen and oxygen with the magnesium produces a vacuum **23**.

FIGURES 15 and 16 illustrate a tubular structure suitable for binding a sphere such as illustrated in FIGURES 1 and 10, into a rigid structure. The ducts or tubes are made of layers of material as hereinafter described, which decompose and melt at predetermined temperatures in a pressure heat furnace, so as to form hollow structures which are bound together in the position in which they are formed. This binder and hollow tube structure consists of a core **31**, similar to the core **1** of FIGURES 1 through 4. The core **31** is preferably covered with a fabric **32** of asbestos. The fabric **32** is then encased in a layer of metal **33**. The outer surface of the metal layer **33** is a surface to which solder or other metal may be applied to bond the tube to the spheres.

The fabric **32** is preferably such that it will burn slowly, yet retain its original shape until the binding material **33** has cooled and chilled to a solid state before the organic fabric has burned and fallen apart.

Once the tubular structures illustrated in FIGURES 15 and 16 are prepared and pressurized, they may then be placed amongst a plurality of pressurized spheres illustrated in FIGURE 3, or vacuum spheres illustrated in FIGURE 12. In order to bind the various spheres and tubes together, it is desired that a binding metal, such as solder, not shown, be applied, so that as the spheres and tubes are heated, the resultant structure, as illustrated in FIGURES 18 and 19, will be accomplished, whereby the spheres and tubes are fused together.

In FIGURE 18 there is schematically illustrated a pressure furnace including sides **37** and top and bottom **39** of the furnace, which are preferably movable so that the spheres and tubes within the furnace which are being heated may expand outwardly against the end or bottom **39** because of the changing volume created by heat treating. On the righthand side of FIGURE 18, represented by the letter B, the completed structure is illustrated in its fused, finished, rigidified form.

A structure such as illustrated in FIGURE 17, formed into desired shapes and sizes, creates efficient heat barriers and/or encasement for machinery parts.

It can be seen that the tubes illustrated in FIGURE 15 are sealed, so that the pressure can be maintained in the core area.

Although I have herein shown and described my invention in what I have conceived to be the most practical and preferred embodiments, it is recognized that departures may be made therefrom within the scope of my invention, which is not to be limited to the details disclosed herein but is to be accorded the full scope of the claims so as to embrace any and all equivalent structures and devices.

I claim:

1. A rigid structure comprising a plurality of substantially equal size, independently sealed, hollow, rigid spheres having an interior pressure substantially different from atmospheric pressure at ground level, said spheres being maintained together in a predetermined rigid shape and compacted to abut one another, a plurality of independently sealed, substantially parallel, hollow tubes, said tubes being diametrically disposed between said spheres, and being of sufficient external diameter when positioned in the spaces between said spheres to abut each of the surrounding spheres, and a rigid bonding mass of filler material which fills the interstices between said spheres and said tubes to bind them together and rigidify the structure.

2. A rigid structure as defined in claim **1**, wherein the interior pressure of the spheres is greater than ground level atmospheric pressure.

3. A rigid structure as defined in claim **1**, wherein the interior pressure of the spheres is less than ground level atmospheric pressure.

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RICHARD O. DEAN, *Primary Examiner.*

U.S. Cl. X.R.

29—191, 191.4, 183.5; 52—615; 89—36