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METHOD OF INSULATING TANKS FOR STORING OR TRANSPORTING LOW-TEMPERATURE LIQUIDS

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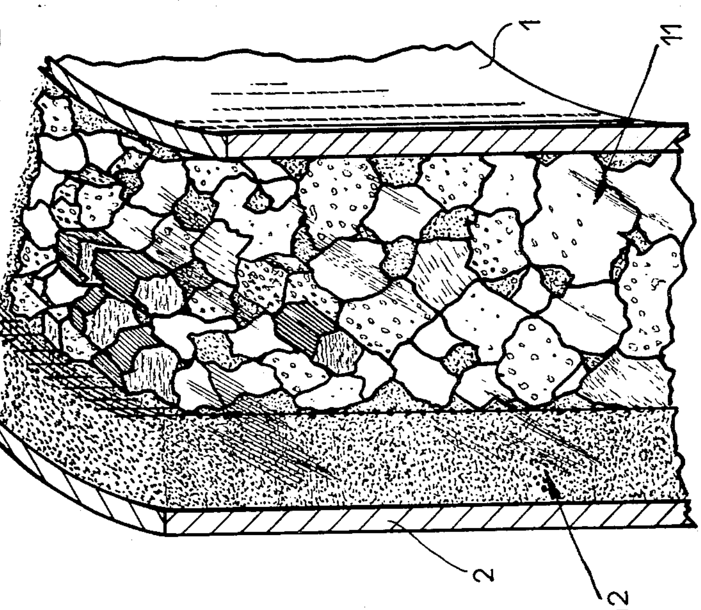
FIG 2



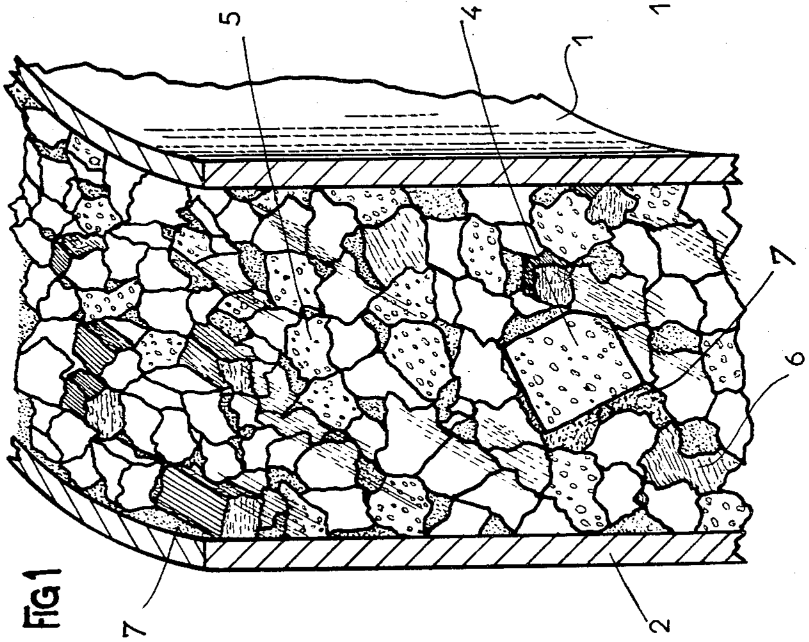


FIG 1

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METHOD OF INSULATING TANKS FOR STORING OR TRANSPORTING LOW-TEMPERATURE LIQUIDS

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6 Claims. (Cl. 20—101)

This invention relates essentially to a method of insulating tanks for storing or transporting liquids or liquefied gases, notably at very low temperature. This insulation method is applicable to a tank comprising a double envelope or wall and having a suitable insulating material disposed between the walls of said envelope.

A conventional heat-insulating method consists in ensuring the thermal insulation of a tank containing a liquid at very low temperature by means of envelope consisting of suitable solid heat-insulating material such as cork sheets, polystyrene, klegecell, balsa wood, etc. The use of these solid insulating materials is attended by many inconveniences. They are extremely costly to lay because the elements are assembled through crossed joints and it is necessary to protect the site against weather conditions during the erection. Moreover with these insulating materials the formation of shrinkage cracks is generally observed during the cooling of the tank as the latter is filled with liquid. Moreover, some of these materials are combustible or disintegrate under the influence of heat (polystyrene, balsa wood) this inconvenience being particularly serious when storing or transporting liquid hydrocarbons.

Pulverulent insulating materials are characterized by certain advantages, compared with solid insulating materials, notably in that they can be laid easily and at low cost. With pulverulent insulating materials all risks of crack formation on shrinkage, when the tank is cooling down, are definitely avoided and moreover they are incombustible and heat resistant. However, pulverulent insulating materials are attended by certain drawbacks when they are used for insulating tanks of relatively great height. In this case, the powder is usually subjected to a certain amount of ramming inside the double-walled envelope containing it, and this ramming action is particularly important in the case of transport tanks due to the jolts and vibration applied thereto. Finally, insulating powders constitute a compressible but non-elastic material, and therefore, due to the alternate shrinkage and expansion of the tank, this powder will gradually descend and then exert a dangerous inward pressure on the tank walls.

To complete this review, another type of insulating material may be referred to, that is, fibrous materials. These are suitable for the purpose but they should only be used with much care for in the case of tanks of relatively great height convection flows between the cold wall of the reservoir and the wall of the outer casing may attain considerable values and are very difficult to avoid with gas pervious materials such as fibrous materials.

In order to take advantage of pulverulent materials while avoiding their drawbacks, it is the essential object of this invention to provide a mixed insulation utilizing a pulverulent materal and a solid material elastically compressible even at very low temperature and having the lowest possible density.

The method of this invention consists in filling the space provided between the two envelopes of the tank to be insulated with a mixture consisting of predetermined proportions of solid insulating grains or lumps and insulating powder in order to form an insulating conglomerate in said space.

According to another feature characterizing this invention, grains or lumps consisting of a low-density solid material which is elastically compressible even at very low temperature are used.

According to another feature of this invention the solid insulating materials in grain or lump form are introduced preferably by discharging them from the top of the aforesaid tank into the space formed between the two walls thereof, and, after the solid insulating material in grain or lump form has been introduced, by pneumatically injecting into said space the insulating powder previously fluidized in a gaseous stream.

This invention is also concerned, by way of novel industrial products, with insulating walls or tanks constructed or treated according to the method broadly set forth hereinabove.

Other features characterizing this invention will appear as the following description proceeds with reference to the accompanying drawing, wherein:

FIGURE 1 is a diagrammatic fragmentary longitudinal section taken across the wall of a tank insulated according to the teachings of this invention, and

FIGURE 2 is a similar view showing a modified embodiment of the tank wall.

In the examples illustrated in the drawing, a tank comprises an inner envelope 1 and an outer envelope 2, the liquid to be stored or transported being contained in the chamber surrounded by the inner envelope 1.

In the form of embodiment illustrated in FIGURE 1 the space formed between the inner and outer envelopes 1, 2 is filled with a conglomerate of solid insulating material in the form of lumps and grains intimately embedded in a mass of insulating powder. Thus, the reference numeral 4 designates a polystyrene lump of substantially cubical configuration, and 5 is a grain of the same material, and 6 is a lump of fibrous material such as mineral wool or the like. All these elements are embedded in insulating powder 7. They have been introduced by discharging the sacks containing them loosely from the top of the tank into the space formed between the double envelope of the tank wall. Subsequently, the insulating powder, previously fluidized in an apparatus of known type, has been injected pneumatically at properly selected and spaced points of the tank.

If for example the density of expanded polystyrene is 0.900 lb./cu. ft. and the insulating powder has a density of the order of 6 to 12 lbs./cu. ft., it is obvious that due to the low density of this solid material the average density of the compound insulating mass can be reduced by one half or even more while reducing proportionally the risk of ramming according to the height of the tank.

The size of the grains or lumps of solid insulating material is extremely variable and depends notably on the thickness of the insulating layer to be formed between the two walls of the tank. To cite an order of magnitude, grains or lumps of a volume ranging from 0.06 to 60 cu. in. may be used.

A conglomerate of the type illustrated diagrammatically in FIGURE 1 which consists of grains embedded in a powder mass is particularly compressible and elastic when the grain-forming material itself is elastically compressible as in the case of expanded polystyrene. The drawbacks inherent to the use of insulating powder, notably the ramming along a vertical tank wall of relatively great height, are thus definitely avoided. In fact, although the compound insulating layer thus formed in the space available between the two envelopes of the tank wall is moderately rammed and in contact with the inner wall when the tank is cold as a consequence of the filling thereof with liquefied gas, during the expansion consequent to the draining of the tank the grain compression is slightly increased but the height of the insulating conglomerate remains unchanged, so that no ramming actually takes place.

Of course, as the tank temperature increases a moderate external pressure acts thereupon, and this may lead one to reinforce the mechanical strength of the assembly by adding a few hoops or frames to the tank wall.

In the foregoing the relative volumetric proportions or weight proportions of the pulverulent insulating material and of the grain or lump material embedded therein are not set forth with precision, because they are extremely variable according to the type of insulation contemplated and notably to the specific characteristics of the two materials utilized, as one material is pulverulent and the other solid, and also to the cost of these materials.

When sufficiently small lumps are used, for example grains of a few tenths of a cubic inch or so at the most, these grains may be deposited in the tank wall space by pneumatic injection as in the case of the pulverulent material, so that the work is simplified and cost reduced accordingly.

FIGURE 2 illustrates an alternate embodiment wherein the insulating material consists almost exclusively of expanded polystyrene. This insulating material is particularly interesting due to its low density, but it is attended by the very serious drawback of "vanishing" when heated to about 175° F. However, specialists will be tempted to use this material for constructing an insulating wall according to this invention, considering its very low specific weight, its high elasticity even at very low temperature, and its low coefficient of conductivity approximating that of pulverulent materials.

In the example illustrated in FIGURE 2 a grid **10**, for example a wire-netting, is disposed coaxially inside the double envelope **1**, **2**, for example at one-fourth of the total gap from the external envelope. This wire-netting has a mesh size smaller than the grain size and therefore the solid material is kept within an annular space **11** in contact with the inner wall of the tank to provide a space **12** between the wire netting and the outer wall, this space being filled only with insulating powder. Of course, with this procedure a heat flow from the outer wall of the tank cannot be attained—at least during a certain time period—the polystyrene having a poor heat resistance, as the layer of insulating powder is interposed between the outer wall of the tank and the polystyrene layer.

In the example described and illustrated herein only the case of the introduction of loose solid materials into the space formed between the two envelopes of the tank has been contemplated by way of example. However, it is possible to inject insulating powder in the same manner for filling in the joints in a coarse assembly of solid insulating blocks such as cork, balsa wood or the like. This procedure is advantageous in that it permits, should the case arise, of drying these materials beforehand within the double envelope before injecting the pulverulent insulating material constituting an advantageous substitute for the pitch generally utilized for filling in the joints between adjacent blocks. In this case as when utilizing particularly gas-pervious fibrous materials an injection of powder will prove very useful. This injection will easily fill in, if necessary, any cracks or gaps formed in a compact insulating layer as a consequence of the shrinkage of the material when the tank is filled with a very cold fluid, for example liquefied gas. This filling in will eliminate convection flows between the walls.

Of course, this invention is not limited to the forms of embodiment described and illustrated herein as many modifications and variations may be brought thereto without departing from the basic principles of the invention as set forth in the appended claims.

What I claim is:

1. Method of insulating a tank for storing liquefied gases at very low temperature, said tank comprising an inner envelope and an outer envelope forming therebetween an annular space, said method consisting in filling said space with a mixture in predetermined proportions of lumps of expanded polystyrene and pulverulent insulating material in order to constitute and insulating conglomerate in said space, a partition means being provided in said annular space formed between the inner envelope and the outer envelope of the tank, said partition means serving the purpose of maintaining the conglomerate of polystyrene lumps and pulverulent insulating material against the inner envelope of tank wall, the space formed between said partition means and the outer envelope being filled only with pulverulent insulating material introduced therein by pneumatic injection.

2. Method as claimed in claim 1 wherein said partition consists of wire netting.

3. Method as claimed in claim 1 wherein said partition means is located nearer to the outer envelope than to the inner envelope of said tank.

4. Method as claimed in claim 1 wherein another injection of insulating pulverulent material is directed into said annular space, after filling the tank with a low-temperature liquid, in order to fill in the interstices created by the shrinkage of the inner envelope of said tank.

5. Method of insulating a tank for storing liquefied gases, at very low temperatures, said tank comprising an inner envelope and an outer envelope forming therebetween an annular space, said method consisting in providing in said annular space partition means, in filling the space provided between said partition means and said inner envelope with lumps of a low density solid insulating material elastically compressible even at very low temperatures together with pulverulent insulating material and in filling the space provided between said partition means and said outer envelope with pulverulent insulating material.

6. Method as claimed in claim 5 wherein said partition consists of wire netting.

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