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F. LAZARI

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PROCESS FOR FILLING AND TREATING PRESSURE CAPSULES FOR USE IN NON-METALLIC FUZES

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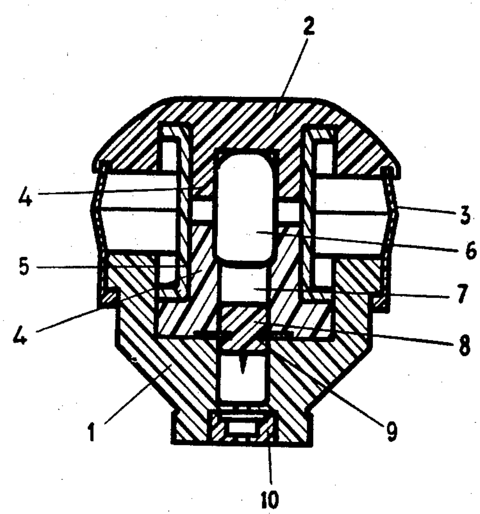

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PROCESS FOR FILLING AND TREATING PRESSURE CAPSULES FOR USE IN NON-METALLIC FUZES

Fabrizio Lazari, Milan, Italy, assignor to Montecatini, Società Generale per l'Industria Mineraria e Chimica, a corporation of Italy

Original application July 17, 1952, Serial No. 299,305. Divided and this application September 26, 1956, Serial No. 612,177

Claims priority, application Italy August 4, 1951

4 Claims. (Cl. 53—25)

This invention, disclosed herein as a division from my copending application Serial No. 299,305, filed July 17, 1952, relates to mine fuzes and is directed particularly to a method for filling and treating pressure capsules for use in non-metallic fuzes.

It is known that the fuzes of antitank and antipersonnel land mines are usually actuated directly by crushing caused by the weight of the object against which the mines are directed.

These fuzes activated by crushing consist essentially of a percussion cap or detonator which is struck by a firing pin when the fuze is subjected to a predetermined force.

Generally, the striker is projected against the sensitive detonator by the force of a spring, previously compressed and held in such condition by a stop system which is rendered ineffective by crushing of the cover of the fuze. In this type of fuze, the release of the spring imparts to the striker a uniform striking force which is always sufficient to insure firing of the detonator.

In other types of fuzes, on the contrary, the striker is pushed against the detonator directly by the impact exerted upon the cover of the fuze, and in this case, according to the circumstances, the force of the impact may or may not be sufficient to ignite the detonator. The last-mentioned type of fuze is particularly adapted for use in non-metallic mines, wherein metallic springs cannot be used.

In applicant's copending application Serial No. 299,305, filed July 17, 1952, entitled Non-Metallic Mine Fuse, there is disclosed a wholly non-magnetic fuze which comprises a detonator, a striker for igniting the detonator, and a pressure capsule for actuating the striker by a constant force of impact independently of the direction in which the mine cover-crushing force is applied.

In particular this effect is attained in the present invention by replacing the predetermined elastic force of a spring by the elastic force of a compressed gas contained in a hermetically sealed container. The gas container is disposed in a chamber at one end of which the striker is slidably fitted as a piston. Breakage of the compressed gas container, upon crushing of the fuze, exerts a pressure upon the striker and projects it against a suitably located percussion cap, striking it with a uniform force always sufficient to ignite the detonator.

The gas container may consist of a vitreous or glass ampoule, which in addition to having the required fragility offers an unexpected high resistance to the internal pressure, in comparison with the necessarily small thickness of the walls. The gas container is preferably charged with a stable gas under a pressure of from 1 to 30 atmospheres.

It is the principal object of the present invention to provide a method for making pressure gas containers in the form of fusion-sealed vitreous or glass ampoules suitable for use in the non-metallic land mine described in the above-mentioned copending application.

Other objects, features and advantages of the invention will be apparent from the following description read in conjunction with the accompanying drawing.

The drawing illustrates in vertical cross-section a fuze embodying a pressure capsule or ampoule made in accordance with the process of the present invention. The fuze consists of a base 1 and cap or cover 2 made of rigid material, having adequate resistance (e. g. synthetic resin) and of a perimetral band 3 made also from stiff material and having a fragility adequate for the sensitivity required of the fuze. Such a band constitutes at the same time the rigid and hermetic connection of the base with the cover and the predetermined fracture zone when the fuze is crushed by a body of a predetermined weight.

Inside the enclosure, composed of the cover 2, the base 1 and the band 3, are two cylindrical coaxial sockets 4 and 4′, respectively, integral with the cover and secured to the base, and surrounded by a plastic material envelope 5. The envelope 5 affords a gas-tight but non-rigid connection between the sockets. Inside the sockets is disposed the compressed gas container 6 made of fragile material (e. g. glass).

The internal cavity of the socket 4′ extends through the base of the fuze in a channel 7, within which at a convenient height the striker 8 is located, operating as a piston. The striker 8 is held in place by a thin and yieldable baffle 9, which serves to preserve the hermetic closure of the pneumatic chamber. Under the striker, the percussion cap 10, containing the blasting fuze, is located.

When the cover of the fuze is subjected to a weight superior to that for which it was adjusted, the band 3 yields, the cover 2 presses against the container 6 breaking it, and the instantaneous pressure exerted by the compressed gas in the channel 7 propels the firing pin against the detonating cap. Breaking of container 6 is also insured even if the cover, which expressly has the form of a mushroom, is pressed marginally, and therefore acts on the container as a torsional couple.

As mentioned above, the container or capsule 6 is preferably a glass ampoule. Since the ampoule contains gas under pressure, special consideration must be given to its manufacture and sealing. For example, one of the following methods could be employed for producing the pressure-containing ampoules:

(1) Welding of the ampoule while contained in a receptacle under pressure.

(2) Welding of the ampoule previously filled with compressed gas retained therein by a provisional closure located internally of the neck to be welded.

(3) Generation of gas under pressure inside the ampoule after welding of the neck.

Among the aforesaid methods the third one constitutes in particular the object of the present invention, and may be easily effected since it requires neither the use of a special apparatus (as the first one) nor ampoules of particular manufacture (as the second).

In general the invention takes advantage of the particular resistance characteristics of glass. It comprises introducing into the ampoule a substance or a mixture of substances in a condensed state, as described below, from which a desired amount of gas is uniformly generated which, being set free in the ampoule after closure thereof by hot welding, exerts a continuous and uniform pressure over the whole inner surface. Breakage of the glass ampoule upon crushing of the fuze is effected by an instantaneous load effecting a tensional force within the glass.

The limit of the glass resistance to compression is considerably superior than that to tension (about

15–20:1). (Rel. Dr. Berger, Jena, V. D. I., 1926, page 129, and K. H. Borchard, V. D. I., 1938, page 1461.)

Moreover, as experimentally observed, ampoules withstanding a great internal pressure for a limited time period (e. g. 3 hours), will withstand it with absolute guaranty for an indefinite time. This fact, with respect to the safety characteristics of the fuze, is very important. On the other hand, the relatively low resistance limit to tension of the ampoule walls, whether due to the glass or to the limited transverse dimensions of the ampoule, makes them very sensitive to instantaneous external blows.

For filling the ampoules, those substances or mixtures of substances are particularly preferred whose gas development may be initiated and controlled after the welding operation on the neck of the ampoule.

It is preferable that the substance or the mixture of substances to be employed be such as to develop the gas by heat action, which, exclusive of luminous radiations, is the most common and measurable agent that may be transmitted through glass.

Among the numerous substances or mixtures of substances producing gas by heat due to chemical reaction or to change of the physical state, it is preferable to proceed in a choice which takes into account the following considerations:

A. The gas, with which the ampoule is filled must have a low liquefaction point, such that for the predetermined internal pressure, no condensation occurs within the limits of temperature to which the ampoule may be subjected.

B. The gas must not be produced from the substance or mixture of substances exhibiting a reversible reaction, in consequence of which the gas pressure would be a function of the equilibrium in conformity with the temperature.

C. The reaction velocity causing the gas development must be easily regulable in order to avoid its occurring too rapidly to prevent the possibility of rupture of the ampoules. Therefore liquids are preferable to solids because of the higher coefficient of heat transfer of the whole device including the ampoule and its contents.

D. The gas development must occur in a temporary range easily attainable, that is to say not excessively low nor high, the former being difficult to keep during welding of the ampoule's neck and the latter being likely to result in a lowering of the mechanical strength characteristics of the glass or causing its breakage by rapid thermal expansion.

E. The gas development must be measurable quantitatively, so as to obtain the predetermined pressure inside the ampoule.

F. The gas must stand the test of time and must not give rise to internal reactions, varying the compositions and specific volume, that is, the pressure, within the limits of room temperature to which the ampoule may be exposed.

G. Neither the gas nor the eventual solid or liquid residues of the substance or of the mixture of substances comprising the gas generators must attack the glass.

A particular feature of the present invention is the use of hydrogen peroxide as generator of gas under pressure within the hot-welded glass ampoule, such substance satisfying all the above-mentioned conditions and its use being of extreme simplicity.

It is well known that hydrogen peroxide is an instable substance, which by heat action or by means of substances acting as catalysts will be decomposed into water and oxygen with sensible heat development.

The reaction proceeds in a practically complete manner, developing an oxygen volume exactly corresponding to the ratio determined analytically.

It has been found that the commercial hydrogen peroxide of 100 volumes concentration is most suitable for use in the present invention, for while the decomposition velocity is easy to regulate, as will be discussed below, it gives a high gas volume in comparison to that of residual water, which occupies therefore a very small part of the ampoule. It is evident however that any hydrogen peroxide solution of high concentration may equally serve for the purpose. Hydrogen peroxide, as well known, is normally stabilized in order to render it preservable. On the contrary, among the numerous methods to cause its decomposition, it is sufficient to alkalize it slightly, which means just the same as an addition of hydroxyl ions. This decomposition, very slow at temperatures of about 0° C., becomes gradually more rapid with increasing temperature; at 50° C. the decomposition is already sufficiently rapid so as to make it unnecessary to heat to higher temperatures, at which the reaction may be excessively tumultuous.

Since, as above mentioned, the reaction is exothermic, it is necessary to restrain it with suitable cooling of the ampoule. This is very easily effected for the reason that the substance which generates the gas is in a liquid state, and therefore the heat exchange through the glass wall is more efficient and uniform than that which could be obtained with a substance in the solid form.

After having analytically determined the oxygen volume concentration of the hydrogen peroxide to be employed, it is required only to inject into each ampoule the calculated quantity for developing that volume of oxygen necessary to create in the inside of the sealed ampoule the preestablished pressure. It is thus evident that the ampoules can be given the required charge of hydrogen peroxide rapidly and simply.

After cooling the amopules to about 0° C. the contents are alkalized slightly and the ampoule necks are welded by a flame while keeping them in the cooling bath. When the welding zone has cooled, the ampoules are immersed in a water-bath having the preferred temperature—e. g. 40° C. The bath must have a sufficient water capacity to act as a thermal flywheel without the necessity of changes or subsidiary cooling, and to initiate at first the decomposition of the hydrogen peroxide contained in the ampoules and then control it by absorption of the reaction heat.

When the visible development of oxygen is finished, the ampoule is ready to be employed and may be preserved indefinitely, without any possibility of internal alterations, and with a variation of the internal gas pressure as a function of the temperature only in conformity of the law of Gay-Lussac.

The immersion of the ampoules in the water bath in order to regulate the decomposition of the hydrogen peroxide contained in its serves also as a means for testing the ampoules in leakage due to imperfect welding of the necks.

I claim:

1. The process for making vitreous containers containing gas under pressure for use as a striker-propelling medium in non-magnetic mines comprising, charging the glass container with a quantity of hydrogen peroxide sufficient to create within the container the predetermined pressure, then cooling the container of about 0° C. in a cooling bath, then alkalizing the contents slightly, and finally sealing-off said container by fusion while still maintaining the body of the container in the cooling bath.

2. The process as defined in claim 1 further including the step of immersing said sealed container in a liquid bath of about 40° C. temperature, whereby decomposition of the hydrogen peroxide is initiated by application of heat, and controlled by subsequent withdrawal of the heat released in the exothermic reaction.

3. In the assembly of a non-metallic fuze for a land mine, the fuze having a striker, a percussion cap and enclosure means in contact with a vitreous frangible hermetically sealed ampoule having a pre-fill of compressed propellant gas, the ampoule being breakable by impact on the fuze, to release the gas and thereby propel

the striker against the percussion cap: the preliminary steps of charging the ampoule with a heat-controllable gas-generating substance, sealing the ampoule, then heat-treating the charged ampoule to produce the desired gas pressure, and positioning the ampoule in the enclosure means.

4. In the assembly of a non-metallic fuze for a land mine, the fuze having a striker, a percussion cap and enclosure means in contact with a vitreous frangible hermetically sealed ampoule having a pre-fill of compressed propellant gas, the ampoule being breakable by impact on the fuze, to release the gas and thereby propel the striker against the percussion cap: the preliminary steps of

charging the ampoule with a heat-controllable gas-generating substance comprising a quantity of hydrogen peroxide sufficient to create within the ampoule the desired predetermined pressure, sealing the ampoule, then heat-treating the charged ampoule to produce the desired gas pressure, and positioning the ampoule in the enclosure means.

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