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HYDROGEN PEROXIDE EXPLOSIVES

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This invention relates to high explosives. An object is to produce a novel high explosive of extremely high strength and rate of detonation, having outstanding advantages not found in the generally adopted commercial uses of such explosives.

This is a very old art wherein highly skilled specialists have for many years been engaged in research work, tests, etc., for the purpose of producing a commercially desirable explosive superior to the accepted compositions including dynamite, or liquid oxygen.

Blasting explosives of the high order, i.e. dynamite, ordinarily consist of a high explosive such as nitroglycerin or nitroglycerol absorbed in a mixture of combustible and oxygen-supplying fillers, such as wood pulp, sodium nitrate, etc. The explosive compounds ammonium nitrate and nitrocellulose are frequently added. The sensitizing ingredient in this class of explosives is nitroglycerin, a definite chemical compound of considerable sensitiveness, which is capable of decomposing by itself with release of large amounts of heat and hot gases. A number of other chemical compounds belong to this category, viz, nitrostarch, mercury fulminate, trinitrotoluene, etc.

Some high explosives are merely physical mixtures of oxidizing and reducing substances. Liquid oxygen absorbed in a carbonaceous material such as lamp black is a case in point. This mixture detonates with a high rate and gives off considerable energy from the heat of reaction between oxygen and carbon. The life of this mixture is short, as its principal constituent, liquid oxygen, boils at −183° C., and thus readily evaporates from the explosive cartridge.

Other mixtures of oxidizing and reducing substances, such as the usual mixtures for black powder, burn or deflagrate rather than detonate, and release a smaller amount of energy at a much lower rate.

The new idea is like using liquid oxygen in that two different ingredients are mixed to provide for detonation. However, my new explosive is more stable, and it avoids numerous perplexing problems involved in the manufacture and storage of liquid oxygen.

Further more, the oxidizing agent of this desirable new product can be combined with numerous simple and inexpensive oxidizable combustible materials and absorbents to produce a very desirable explosive of extremely high strength and rate of detonation.

More specifically stated, my study of the subject, followed by actual tests, has very clearly shown that an outstanding feature of the improved explosive appears in the use of a strong solution of hydrogen peroxide as an oxidizing agent. When compared with liquid oxygen, hydrogen peroxide is reasonably stable in storage of the high explosives, and it also eliminates various troublesome and expensive details involved in the use of liquid oxygen.

In various actual tests, I employed different combustible and absorbent materials with a strong solution of hydrogen peroxide (90%), and found that it is necessary to use a strong solution. However, the invention is not limited to a 90% solution. Weaker solutions of hydrogen peroxide and water are less expensive, and while I have used such solutions having strengths as low as 59.9% and 70%, I prefer a range between about 75% and about 90% for explosive mixtures to be detonated with a blasting cap. The 90% solution of hydrogen peroxide and water is quite desirable.

An important object of the invention is to produce a high explosive of this type, including a solution of hydrogen peroxide and water mixed with any suitable oxidizable combustible material to create a novel explosive mixture of extremely high strength and rate of detonation. I will refer to specific examples of numerous different oxidizable combustible materials, including finely divided absorbent sensitizing agents wherein the hydrogen peroxide solution is absorbed, and also give specific examples of various percentages of the different ingredients. However, it would not be feasible to specifically set forth all of the different kinds of combustible materials, nor all of the specific percentages. It is to be understood that the invention is rather broadly directed to a novel use of strong hydrogen peroxide solutions, and not limited to the specific details, except as specified in the claims hereunto appended.

However, the percentage of combustible material in the explosive mixture is preferably less than that of the hydrogen peroxide solution, but sufficient to render the mixture sensitive to detonation with a blasting cap. More specifically stated, the strong hydrogen peroxide solution is preferably more than 60% of the mixture while the combustible material is less than 40%. For example, the hydrogen peroxide solution may form between 65% and 85% of the explosive mixture. Furthermore, while I will refer to specific examples wherein only one kind of combustible material is employed in each explosive composition, it will be apparent that two or more different kinds of combustible materials may be combined with each other in a single explosive.

I will now refer to a number of different combustible materials which may be used as absorbent fillers in formulating my new hydrogen peroxide explosive. The following are conveniently grouped into classes, and are illustrative of the wide choice available.

Wood products.—Fine sawdust, and wood pulp or wood meal from trees such as pine, fir, spruce, hickory, etc., and also ground cork.

Grain hulls.—Hulls of oats, rice, wheat and corn may be ground or used in a whole condition. The hulls of soy beans and peanuts are ground for use in a finely divided condition.

Straw or chaff.—This clas of material is preferably ground, and may be derived from wheat, flax shives, corn stalks, hemp hurds, sugar cane bagasse, etc.

Pits and shells.—This class of material is to be ground or otherwise comminuted, and may be derived from ivory nuts, apricot pits, cherry pits, walnut shells, filbert shells, cotton burrs, corn cobs, cocoa hulls, etc.

Miscellaneous woody products.—Examples of miscellaneous woody products include spaghnum moss, mallow pith, arrowroot top growth, lemon grass pulp, etc.

Synthetic products.—Inexpensive synthetic products include thermosetting or thermoplastic synthetic resins, such as phenol-formaldehyde, urea-formaldehyde, methyl methacrylate, etc. Another illustration appears in cuprene (polymerized acetylene).

Pulverized metals.—Suitable metals include aluminum, tin, etc., in a powdered condition.

Gelatinous explosives.—The hydrogen peroxide solutions herein referred to may be combined with various gel-forming products from grains and other materials to produce gelatinous explosives adapted to be detonated with blasting caps. For example, I can use flours derived from wheat, corn, barley, oats, rye, buckwheat, malt, etc. Other illustrations appear in starches made from corn, wheat, potatoes, manioc, tapioca, etc. Agar-agar may be used alone or combined with other ingredients, and in any case two or more ingredients may be employed to produce the combustible sensitizing agent.

Examples of tests wherein specific mixtures were successfully detonated with No. 6 blasting caps appear as follows:

A mixture comprising

76.8% hydrogen peroxide (90%), and
23.2% wood pulp

resulted in a high explosive having a density of 1.18 grams per cubic centimeter, a count of 130, 1¼" x 8" cartridges per 50 pounds, with a rate of detonation at 18,800 feet per second, and a strength by ballistic mortar of 115%, nitroglycerin being rated at 100%. The original wood pulp was in the form of a dry powder, finer than sawdust. Study of this specific test indicated that wood pulp or wood meal amounting to about 20% of the mixture would be more desirable, and that a range between about 15% and 30% would produce a desirable explosive.

A second example appears in a test of

75% hydrogen peroxide (90%), and
25% fine sawdust,

This mixture formed a cohesive mass similar to a mixture of sawdust and water, and it also resulted in a highly violent explosion when detonated with a No. 6 blasting cap. In other successful tests, the proportions of sawdust were 15% and 28%, respectively. Study of this situation indicated that an optimum percentage of the sawdust would probably be about 20%, with a desirable range between about 15% and about 35% for less effective results. However, the sawdust is preferably between 20% and 23.3% of the mixture.

A third example of the use of a strong solution of hydrogen peroxide wherein a No. 6 blasting cap was employed for successful detonation appears in a test of bagasse, ground into fine shreds, which formed 25% of the mixture.

Ground corn cobs, ground rice hulls and ground oat hulls, each forming 25% of a hydrogen peroxide mixture, likewise resulted in explosive compositions which were successfully detonated with number 6 blasting caps. All of this clearly shows that numerous different combustible and absorbent materials can be combined with a relatively high percentage of a strong solution of hydrogen peroxide, so as to actually produce a real innovation in this old art. Careful consideration of these tests showed that new compositions of this type are more powerful than dynamite, and that they lack many objections found in the use of liquid oxygen.

The relative strengths of explosives comprising concentrated hydrogen peroxide and oxidizable materials is shown by a study of the heat evolved in decomposition. Nitroglycerin is known to evolve upon detonation about 1,500 calories of heat per gram, at constant volume. Hydrogen peroxide, in decomposing according to the following evolves about 690 calories per gram.

$$H_2O_2 = H_2O + O$$

As cellulose produces about 4,180 calories per gram when burned in oxygen, it may be calculated that a balanced mixture of cellulose and concentrated hydrogen peroxide will produce about 1,680 calories of heat. This reaction may be expressed as follows:

$$\underset{408\text{ grams}}{12H_2O_2} + \underset{162\text{ grams}}{(C_6H_{10}O_5)_x} = \underset{264\text{ grams}}{6CO_2} + \underset{306\text{ grams}}{17H_2O}$$

While the total quantity of heat is not a true measure of the strength of an explosive, as it is not all available for doing useful work, much being used in vaporizing the water and raising the temperature of the gases, a comparison of the heats of decomposition affords a method of comparison. By this criterion, a balanced mixture of concentrated hydrogen peroxide and cellulose, the principal constituent of wood substance, is evidently stronger than nitroglycerin.

In using metals such as aluminum, tin, etc. as the oxidizable combustible material, the metal is pulverized into

fine dust or powder, preferably much finer than 200 mesh. An optimum quantity of aluminum dust is about 32.2% of the explosive mixture, but the optimum for pulverized tin is about 61%. Of course, desirable results can be obtained while departing considerably from these percentages, and especially when the metals are employed with other combustible materials.

A commercially desirable aluminum powder is known as "paint grade," composed of extremely fine particles, evidently about .0005" to .00025" in diameter. This very satisfactory grade is considerably finer than a product identified as "Powdered Aluminum—200 Mesh." The commercially available aluminum dust referred to as "paint grade" is likely to be coated with a small percentage of lubricant, say 0.2%, which results in an undesirable oily or greasy condition. However, I have found that the addition of a wetting agent (alcohol, for example) will enable this greasy dust to readily mix with the solution of hydrogen peroxide and water. A specific example appears as follows:

	Percent
Hydrogen peroxide solution	66.8
Oily aluminum dust	31.7
Alcohol	1.5

This resulted in a very high explosive, which was readily produced in a creamy, sticky condition and successfully detonated with a No. 6 blasting cap.

Gelatinous Mixtures

I have previously described the numerous gel-forming materials for use with the strong solutions of hydrogen peroxide and water, and will add that the quantity of gel-forming material is preferably less than that of the hydrogen peroxide solution but sufficient to render the gelatinous explosive mixture sensitive to detonation with a blasting cap. Finely divided combustible gel-forming materials of vegetable origin are quite desirable, and may be in the form of starches or flours derived from grains and mixed with the strong hydrogen peroxide solutions.

Corn starch is an illustration of a very inexpensive gel-forming material which may form any desired percentage of the explosive mixture depending partly upon whether it is used alone or with other combustible gel-forming ingredients. When used alone as the gel-forming agent, the quantity of corn starch is preferably between 20% and 30% of the explosive mixture, but lower or higher percentages may be employed for less desirable explosives. A specific example is given as follows:

	Percent by weight
Hydrogen peroxide solution	75
Corn starch	25

This mixture formed a jelly at ordinary atmospheric temperature, without heating, and was successfully detonated with a No. 6 blasting cap. I employed a 90% solution of hydrogen peroxide and water, and prefer to use a solution of this kind ranging between about 75% and about 90%.

Another specific example is found in—

	Percent by weight
Hydrogen peroxide solution	75
Corn flour	25

This mixture jelled rapidly, making a stiff, rubbery, sticky, dense gel, with no gas evolution, and was very effectively detonated with a No. 6 blasting cap.

A desirable feature of the present invention appears in the value of the new high explosive in violent blasting operations, where standard blasting caps are employed. Numerous tests have clearly shown that explosive mixtures conforming to the invention can be very effectively detonated with No. 6 blasting caps. In the manufacture of blasting cartridges, the mixture of hydrogen peroxide is readily located in a suitable shell or container, usually in the form of a cylinder 1¼″ x 8″, and the blasting cap may be arranged therein in any desired manner.

Novel conditions of the method include the step of absorbing the strong hydrogen peroxide solution in the combustible, oxidizable material, the quantity of said material being sufficient to render the mixture sensitive to detonation with a blasting cap. More specifically stated, the method includes the steps of introducing a measured quantity of finely divided absorbent, combustible, sensitizing material into a suitable container, which may be the shell of a cartridge. If desired, this absorbent material can be tamped or packed in the container. A predetermined measured quantity of the strong hydrogen peroxide solution is poured, or discharged, into the mass of absorbent material in the container, thereby causing said material to absorb the liquid solution, and a blasting cap may be suitably arranged in the resultant explosive mixture.

Examples of stabilizers for the hydrogen peroxide solution include acetanilide, phosphoric acid, or the phosphates.

The percentage of hydrogen peroxide may be reduced by adding some other oxidizing agent, examples of which appear in sodium nitrate and ammonium nitrate, the latter being an explosive which would also provide for a reduction in the percentage of the combustible materials herein described. The following is an example including these inexpensive materials.

	Percent
90% hydrogen peroxide solution	50.0
Sodium nitrate, fine	19.3
Ammonium nitrate, fine	10.0
Wood pulp	20.7

This mixture was readily produced in a dry, bulky condition, with no gas evolution, and successfully shot with a No. 6 blasting cap.

The percentages or relative quantities of ingredients of the explosive mixtures herein described are given by weight.

I claim:

1. A high explosive comprising a solution of hydrogen peroxide and water, the hydrogen peroxide being between about 75% and about 90% of said solution, and finely divided solid combustible material mixed with said hydrogen peroxide solution to render the mixture sensitive to detonation with a blasting cap, said hydrogen peroxide solution being between about 65% and 85% of the explosive mixture, and the finely divided combustible material being between about 35% and 15% of said mixture.

2. A high explosive comprising hydrogen peroxide solution having a strength of about 90%, and finely divided solid combustible absorbent material mixed with said hydrogen peroxide solution to render the mixture sensitive to detonation with a No. 6 blasting cap, said hydrogen peroxide solution being between about 65% and 85% of the explosive mixture, and the finely divided combustible material being between about 35% and 15% of said mixture.

3. A high explosive comprising a solution of hydrogen peroxide and water, the hydrogen peroxide being between about 75% and about 90% of said solution, and a finely divided absorbent mass of solid sensitizing material of vegetable origin mixed with said hydrogen peroxide solution, so as to effectively absorb the solution in said mass and render the mixture sensitive to detonation with a blasting cap, said hydrogen peroxide solution being between about 65% and 85% of the explosive mixture, and the finely divided mass of vegetable material being between about 35% and 15% of said mixture.

4. A high explosive as claimed in claim 3 wherein the absorbent mass of sensitizing material of vegetable origin is finely divided grain hulls.

5. A high explosive as claimed in claim 3 wherein the absorbent mass of sensitizing material of vegetable origin is finely divided oat hulls.

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