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EXPLOSIVE COMPOSITION

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This invention relates to explosive compositions of improved power and safety and more particularly to explosive compositions containing a liquid sensitizing agent which is insensitive to impact, and to explosive compositions which do not contain liquid explosives sensitive to friction.

Explosive compositions which have been used by the prior art have normally been divided into two classes; first, sensitive explosives which contain nitroglycerin or admixtures of nitroglycerin with other nitric esters which are sensitive to impact, and explosive compositions containing no explosive sensitizer which is sensitive to impact. The art has found the use of nitroglycerin explosives extremely useful in blasting operations. However, for a number of operations, it is preferable to use explosives that are relatively insensitive to detonation and are completely or almost completely insensitive to impact and to friction. The insensitive explosives usually comprise an explosive salt such as ammonium nitrate in admixture with other salts such as sodium or potassium nitrate and carbonaceous materials such as wood pulp, starch, ivory meal and similar substances together with a sensitizer such as dinitrotoluene, trinitrotoluene, or other materials that are insensitive to impact. These types of explosives are used in many operations where it is especially desirable to eliminate the hazards introduced by the use of sensitive explosives.

It is an object of this invention to provide an explosive which is relatively safe to handle. A further object of this invention is to provide an explosive insensitive to impact but which may be detonated with a commercial blasting cap. A further object of this invention is to provide an explosive composition that does not contain a liquid explosive sensitive to impact or friction.

A further object of this invention is to provide an explosive composition that is relatively safe during packing operations and during the loading of bore holes. A further object of this invention is to provide an explosive which is insensitive to impact and which is cap insensitive. Another object of this invention is to provide an explosive composition that contains a liquid nitroparaffin as the sensitizing agent. Other objects will become apparent hereinafter.

In general, the objects of this invention are accomplished by compounding an explosive composition which contains an admixture of oxidizing salts, such as, for example, ammonium, sodium or potassium nitrate; with a reducing or carbonaceous material, such as, for example, wood flour, ivory meal, balsa or bagasse, coal and the like; and a liquid nitroparaffin, such as, for example, nitromethane, nitroethane, dinitroethane, dinitropropane or other liquid nitroparaffins which has an oxygen balance not lower than about —100%.

The manufacture of explosives of this invention is carried out in any of the various manners well known to the art, and may include, for example, a procedure comprising the screening into a mixer, such as a Talley mixer, an amount of an oxidizing salt, such as sodium, potassium or ammonium nitrate, alone or in admixture with one another along with an amount of carbonaceous or reducing material, such as wood flour, balsa, bagasse, etc. The Talley mixer bowl contains the desired amount of a liquid nitroparaffin alone or mixed with other nitroparaffins to obtain a mixture of the desired oxygen balance and sensitivity. The Talley mixer after the ingredients are thoroughly mixed is dumped and the explosive composition packed into normal cartridges that may be manufactured from paper, plastic or metal. The cartridges may be of any convenient diameter, but normally will have a diameter greater than about 2 inches as the type explosives of this invention are generally found most useful in quarrying work or in large operations where the large diameter cartridges are desired.

The liquid nitroparaffins in themselves are not explosives; i. e., they will not detonate with a commercial blasting cap. However, balanced explosive compositions containing liquid nitroparaffins produce a quantity of explosive energy approaching that of explosive compositions containing the same percentage of nitroglycerin. The oxygen balance of the nitroparaffins is very low, and, therefore, care in compounding an explosive composition must be exercised as, if the oxygen balance of the final explosive composition is too low, difficulty in effecting detonation is experienced. Thus, for example, nitromethane has an oxygen balance of —39.3%; nitroethane, an oxygen balance of —96%; dinitroethane, an oxygen balance of —26.7%; and dinitropropane, an oxygen balance of —59.7%. The liquid nitroparaffins having a smaller proportion of oxygen than nitroethane have such low oxygen balances that they preferably are not to be used alone in explosives, but they may find use in conjunction with the lower nitroparaffins. For example, suitable mixtures may include a solution containing two parts of nitromethane and one part of nitrobutane by weight with an oxygen

balance of −81% or a solution containing equal parts by weight of nitromethane and nitropropane with an oxygen balance of −87%. Therefore, my invention does not contemplate the use of nitroparaffins or mixtures of nitroparaffins having an oxygen balance lower than −100% alone in explosive compositions.

As a specific example of carrying out my invention, I may admix 69 parts by weight of ammonium nitrate with 29 parts by weight of nitromethane and two parts by weight of balsa pulp. The admixture after thorough incorporation is packed into cartridges, and is sensitive to detonation by a No. 6 blasting cap and is found to be a very desirable explosive. Further, the same mixture when tested by the "halved cartridge method of propagation" will cause detonation across a gap as great as 10 inches. It is believed that the nitromethane causes detonation of the composition by interreaction with the oxidizing materials, especially the ammonium nitrate. The reaction may be initiated by a blasting cap but not by an impact and thus provides for the production of a very safe but cap sensitive explosive composition. However, this theory is not to be construed as limiting this invention.

A further advantage of the above type explosive over the nitroglycerin containing explosive composition is that nitromethane does not cause the operators to develop headaches when the explosives are handled; and, further, by itself it will not freeze above −15° F. so that when a composition containing nitromethane is used in normal operations, freezing can not occur until this temperature is reached, and often will not occur until a much lower temperature is reached. If freezing of a nitromethane powder occurs, the effect is not as hazardous as the freezing of nitroglycerin powders since the explosive is much less sensitive to thawing operations. Furthermore, the freezing point can readily be lowered by addition of suitable proportions of other liquid nitroparaffins.

In order to point out the invention more specifically, the following examples are given of explosive compositions containing liquid nitroparaffins in varying proportions as the sensitizing ingredients. The compositions of a number of explosives are given in Table 1, and their various properties are listed.

Table 1

	Sample			
	A	B	C	D
Nitromethane ..... per cent	5.0	20.0	40.0	29.0
Ammonium nitrate ..... do	90.3	74.0	.....	69.0
Sodium nitrate ..... do	.....	.....	48.0	.....
Wood flour ..... do	.....	6.0	12.0	.....
Coal ..... do	4.7	.....	.....	.....
Balsa ..... do	.....	.....	.....	2.0
	100.0	100.0	100.0	100.0
Oxygen balance (ingredients) per cent	+4.0	−1.8	−10.2	−0.6
Count, 1¼ x 8"/50#	157	152	148	115
Sensitiveness [3]	½"	6"	10"	6"
Detonation rate ..... m./sec.	.....	3,200	3,100	3,900
Sensitiveness to impact [1] ..... cm.	.....	P 100	P 100	P 100
Sensitiveness to rifle bullet [2]	(4)	(4)	(5)	(5)

[1] Tested on impact machine, 2 kg. falling weight; P=partial shot or slight crackling.
[2] Tested by impact of 30-06 bullet from U. S. Army rifle at 120 yards.
[3] When primed with a No. 6 blasting cap.
[4] Not tested.
[5] Did not shoot.

Other cap sensitive explosive compositions may be prepared in which the nitromethane is replaced by dinitroethane or dinitropropane.

It has been found that other explosive compositions may be prepared, with nitroparaffins, which are not sensitive to detonation by a commercial blasting cap but are sensitive to detonation by a booster charge. Thus, for example, it is possible to produce an explosive composition which furnishes a high amount of power when it detonates, but which is so insensitive that a booster, such as a half stick of 40% dynamite or a charge of trinitrotoluene or tetryl must be used to prime the composition. In general, this type of insensitive explosive composition is prepared by decreasing the percent of the nitroparaffin present or by using a nitroparaffin having a lower oxygen balance or by combining these two features.

To illustrate the type of explosive compositions which are compounded to be insensitive to detonation by a commercial blasting cap, Table 2 is given wherein the composition and properties of an extra and straight dynamite are listed.

Table 2

Sample	A	B
	Per cent	*Per cent*
Nitroethane	18.0	25
Ammonium nitrate	75.0	.....
Sodium nitrate	5.0	68.5
Bagasse	2.0	6.5
	100.0	100.0
Oxygen balance (ingredients)	−3.0	−0.9
Count, 1¼ x 8"/50#	119	135
Sensitiveness:		
Primed with No. 8 cap	Failed	Failed
Primed with ½ stick 40% dynamite	Shot	Shot

To illustrate gelatin type dynamites containing nitroparaffin, Table 3 is given wherein the composition and properties of a gelatin explosive are listed.

Table 3

Sample	A
	Per cent
Nitromethane	42.9
Nitrocellulose	1.33
Sodium nitrate	47.4
Wood flour	8.37
	100.0
Oxygen balance (ingredients) ..... per cent	−7.1
Count, 1¼ x 8"/50#	98
Sensitiveness:	
Primed with No. 8 cap	Failed
Primed with ½ stick 40% dynamite	Shot
Weight strength ..... per cent	40.5

[1] Determined with ballistic mortar.

It will be understood by those skilled in the art that similar explosive compositions may be prepared by using mixtures of nitromethane with the higher nitroparaffins such as nitropropane and nitrobutane, and that the sensitiveness of such explosive compositions may be controlled by varying the composition of the nitroparaffin mixtures as, for example, by altering the nitromethane and nitroethane content.

It has been found that the explosives containing nitroparaffins such as nitromethane, nitroethane and the like are advantageous because they are highly insensitive to impact and friction and in consequence are especially adapted for packing into metal cans. These nitroparaffin explosive compositions that are cap sensitive may

ıe manufactured and packed with automatic ma-
hinery into a metal can without the danger
vhich this type of operation entails when nitro-
lycerin containing explosive compositions which
ıre sensitive to impact and friction are manufac-
ured and packed with automatic machinery.

The advantages of the nitroparaffin explosives
ver the known explosive compositions are in-
ensitivity to impact, lack of causing headaches,
nd low freezing points, while still being capable
f being manufactured to any degree of cap sen-
itivity.

The explosives of this invention have been
ound to be highly desirable in all blasting opera-
ions when packed in the desired size and type
ontainers. The preferred use, however, is in
arge operations such as open pit mining and
uarry blasting, where the explosive compositions
nay be used in large diameter cartridges of
netal, paper or plastic.

The term "oxygen balance" used in the specifi-
ation and claims is well known and accepted by
he art. The "oxygen balance" of an explosive
ompound is calculated by determining the total
veight of the compound and dividing this weight
nto the difference between the weight of the
oxygen required to completely oxidize the ele-
nents of the compound and the weight of the
oxygen actually present in the compound.

The "halved cartridge gap method" is a stand-
ard explosive composition test and is described
fully in Bulletin 346 issued by the U. S. Bureau
of Mines.

It will be understood that the details and ex-
amples hereinbefore set forth are illustrative only, and that the invention as broadly described and claimed is in no way limited thereby.

What I claim and desire to protect by Letters Patent is:

1. An explosive composition comprising an oxygen deficient liquid nitroparaffin containing not more than two nitro groups and having an oxygen balance in excess of about —100% in admixture with an oxidizing salt and a carbonaceous material.

2. An explosive composition comprising an oxygen deficient liquid nitroparaffin containing not more than two nitro groups and having an oxygen balance in excess of about —100% in admixture with ammonium nitrate and a carbonaceous material.

3. An explosive composition comprising nitromethane having an oxygen balance in excess of about —100% in admixture with an oxidizing salt and a carbonaceous material.

4. An explosive composition comprising nitroethane having an oxygen balance in excess of about —100% in admixture with an oxidizing salt and a carbonaceous material.

5. An explosive composition comprising between about 5% and about 45% of nitromethane having an oxygen balance in excess of about —100% in admixture with an inorganic nitrate and a carbonaceous material.

6. An explosive composition comprising between about 15% and about 25% of nitroethane having an oxygen balance in excess of about —100% in admixture with an inorganic nitrate and a carbonaceous material.

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