

UNITED STATES PATENT OFFICE

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EXPLOSIVE COMPOSITION

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This invention relates to an explosive and particularly to an ammonium nitrate composition that is especially satisfactory in each of several properties that in combination have been heretofore considered unobtainable in an ammonium nitrate explosive.

It is desirable that an explosive for commercial use be relatively insensitive to impact and friction such as might cause premature explosion in handling and, on the other hand, should be sensitive to detonators of the kind used to initiate explosion and should transmit explosion through a gap which may separate parts of a charge during use.

Commercial explosive compositions having an ammonium nitrate base frequently represent a compromise between these contradictory properties. Ingredients of certain classes are incorporated to impart each of the desired properties to the greatest extent permissible without destroying completely other desired properties. Certain materials, for instance, are added for the purpose of sensitizing the explosive to detonators or to transmission of explosion through a gap and another ingredient is added to decrease somewhat the sensitiveness to explosion on impact or friction.

I have now found a sensitizer that may be used to make an explosive mixture that accepts a detonation or explosive wave readily but without increasing objectionably the tendency of the mixture to explode prematurely on impact or friction.

The sensitizer which I have discovered and which shows the desired combination of effect of sensitizing to detonation without increasing seriously the sensitivity to impact is a mixture of pentaerythritol tetranitrate (PETN) and trinitrotoluene (TNT), this sensitizer being preferably fine crystals of pentaerythritol tetranitrate coated with trinitrotoluene, such as are obtained by coprecipitating the pentaerythritol tetranitrate and trinitrotoluene from a solution of these substances by causing the pentaerythritol tetranitrate to precipitate first in the form of fine crystals followed by the separation of the trinitrotoluene from the solution chiefly as a coating on most of the pentaerythritol tetranitrate crystals. This product is commonly known as pentolite and it can be made by forming a hot concentrated solution of pentaerythritol tetranitrate and trinitrotoluene in acetone and injecting this solution into water.

In the preferred embodiment, the invention comprises an explosive composition containing

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ammonium nitrate as the base or most abundant explosive material and the pentaerythritol tetranitrate-trinitrotoluene sensitizer, suitably with the addition of sodium nitrate and preferably also minor proportions of mineral oil and aluminum powder. Preferably the trinitrotoluene is used in amount at least equal to that of the pentaerythritol tetranitrate and the individual granules contain on the average at least 50 parts of trinitrotoluene for 50 parts of the pentaerythritol tetranitrate in the granules.

The explosives so made have the unusual characteristics of being relatively insensitive to impact, requiring the drop of a 10 kg. weight thru 25 to 30 cm. to bring about their explosion, while being very sensitive to a detonator (exploding from a No. 1 detonator to a No. 2½ detonator). Usually an explosive that is quite sensitive to a detonator of low strength is relatively sensitive to impact. Still more remarkable is the fact that, in these mixtures, we have an explosive that jumps across a wide gap (up to 24 cm.) and yet is relatively insensitive to impact. Usually an explosive that has a good gap test is sensitive to impact, and it is actually this sensitiveness to impact that gives it its good gap test.

Suitable ranges of proportions of the several ingredients in the whole explosive composition are shown in the following table.

Ingredient	Parts by Weight for Total of 100 Parts	
	Satisfactory Proportion	Preferred Proportion
Ammonium nitrate.....	40 -75	50 -68
Pentaerythritol tetranitrate ¹	2 -12	3 -10
Trinitrotoluene ¹	2 -20	4 -15
Sodium nitrate.....	5 -30	7.5-25
Mineral oil.....	0.25-1	0.4-0.7
Aluminum powder.....	1 -3	2 -2.5

¹ The pentaerythritol tetranitrate and at least an equal weight of the trinitrotoluene are included together in the same granules. The trinitrotoluene may be present either as a coating over the granules or as an intimate blend with the pentaerythritol tetranitrate extending throughout the granules and into the surface thereof in the manner resulting from cocrystallization of these compounds from a solution with or without the use of a solvent. Such a product is known as pentolite.

The latter three ingredients in the above table may be omitted although their inclusion improves the product. The oil decreases absorption of water and decreases also dustiness of the composition. The sodium nitrate is used to provide suitable oxygen balance in the explosive and aluminum increases the explosive effect, by increasing the temperature of explosion.

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In making the improved explosive composition, the ingredients are mixed in manner that is usual in the making of explosives of the type to which the invention is directed, with the exception that the improved sensitizer is incorporated in place of the usual sensitizer.

My sensitizer is preferably added as preformed granules including the pentaerythritol tetranitrate and trinitrotoluene.

The ammonium nitrate is granular and for best results is of such size as to pass substantially completely through an 8 mesh screen and be retained largely on 230 mesh.

Sodium nitrate when used should preferably be chiefly between 8 mesh and 120 mesh in particle size.

The particles of sensitizer should be fine. Thus they may be of size to pass substantially completely through 40 mesh and preferably through 80 mesh. A typical sensitizer showed 100% through 80 mesh, 75% through 120 mesh, and 20-25% through a 230 mesh screen.

When the various ingredients have been compounded, the finished explosive is then tested for the desirable combination of properties by means of the impact test, detonation, sensitive test, and gap test made as described below.

The impact test consists of dropping a 2 or 10 kg. weight onto a well supported steel anvil on which is placed the explosive under test. The falling weight travels in guides and the explosive under test is placed between two hardened steel, smooth finished discs about $\frac{1}{2}$ " in diameter x $\frac{3}{16}$ " thick. The discs are contained in a holder so that when the falling weight strikes the top disc there is very little, if any, sliding action of the discs. The quantity of explosive used in this test is 0.1 gm. The result is expressed as cm. of fall of the weight required for explosion.

The detonation test consists merely of attempting to fire the explosive with detonators containing various amounts of fulminate of mercury. The higher the numbers of the detonator required, the more fulminate of mercury it contains.

The gap test is made by rolling two $1\frac{1}{4}$ " x 8" regular cartridges of the powder in a paper tube so that the cartridges are end to end. A determination is then made of the maximum distance the cartridges can be separated and still have the detonation of the cartridge jump the air gap separating the cartridges and effect detonation of the other cartridge.

Examples of compositions made in accordance with the invention are described below. The sensitizer used consisted of particles of pentaerythritol tetranitrate coated with an equal weight of trinitrotoluene represented in the tables by the term Pentolite 50/50, supplemented in some cases with additional trinitrotoluene.

Composition	#1	#2	#3	#4	#5
Trinitrotoluene, percent..	9.0	0	17.0	0	0
Pentolite 50/50, do.....	5.0	14.0	5.0	22.0	22.0
Ammonium nitrate, do.....	68.0	68.0	68.0	68.0	50.0
Sodium nitrate, do.....	15.5	15.5	7.5	7.5	25.5
Miscral oil, do.....	.5	.5	.5	.5	.5
Aluminum powder, do.....	2.0	2.0	2.0	2.0	2.0
Detonator Sensitiveness...	$1\frac{1}{2}$	1 to $1\frac{1}{2}$	$1\frac{1}{2}$	1 to $1\frac{1}{2}$	$1\frac{1}{2}$
Gap Test, cm.....	16	35	25	35-40	35
Impact:					
2 Kg. Wt., cm.....	100	160	100	100	100
10 Kg. Wt., cm.....	30	20	30	20	15

In the above it will be noted that mixtures 1 and 3 contain a quantity of granular trinitrotoluene in addition to the trinitrotoluene which

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is associated with the pentaerythritol tetranitrate as pentolite. Starch nitrate can also be substituted pound for pound for the unassociated trinitrotoluene in these mixtures with excellent results as to the desired increased gap sensitiveness without increasing substantially the sensitiveness to impact or friction.

It will be noted that all of the mixtures with the pentaerythritol tetranitrate present in the form of Pentolite 50/50, either with or without additional unassociated trinitrotoluene, show a detonator sensitiveness between $\frac{1}{2}$ and $1\frac{1}{2}$, a gap test of 16-40 centimeters, and impact test with 2 kg. weight, for instance, that is 100 centimeters in every case and varies from 30 centimeters to 15 centimeters in distance of fall of a 10 kg. weight required to set off the explosive. For comparison, there are shown tests for a comparable explosive omitting the present sensitizer. This explosive of the following composition

	Per cent
Ammonium nitrate	79.0
Sodium nitrate	18.0
Oil	.5
Aluminum	2.5
	100.0

showed a detonator sensitiveness of 4 to 5, a gap test of 2 cm. and impact test with 2 kg. weight of 100 cm., and impact test with 10 kg. weight of 35-40 cm. This explosive is essentially #2 of the tabulation with the 14% of pentolite removed.

From the comparison it will be seen that the use of the Pentolite, either alone or in conjunction with unassociated trinitrotoluene, has greatly improved the detonator and gap sensitiveness without any objectionable change in its tendency to explode in the impact test.

While trinitrotoluene is particularly satisfactory as the explosive to be incorporated with pentaerythritol tetranitrate to form pentolite which acts as my sensitizer, satisfactory results are obtained when small amounts of additional sensitizers such as unassociated trinitrotoluene or starch nitrate is used in the composition since preservation of a desirable combination of sensitiveness to accepting a detonation or explosive wave readily, as from a blasting cap or through a gap between time charges of the explosive, and insensitiveness of the explosive mixture to accidental explosion by friction or impact are maintained. In other words in composition #3 above, all or part of the 17% of trinitrotoluene (none of which is associated with the pentaerythritol tetranitrate in the comingled granules) can be substituted by starch nitrate.

It will be understood also that it is intended to cover all changes and modifications of the example of the invention herein chosen for the purpose of illustration which do not constitute departure from the spirit and scope of the invention.

What is claimed is:

1. An explosive composition comprising a mixture of granules consisting of ammonium nitrate, granules of pentolite consisting of blended trinitrotoluene and pentaerythritol tetranitrate, and starch nitrate, the proportions by weight of the several ingredients for 100 parts of the explosive composition being as follows: ammonium nitrate 40-75 parts, pentolite 5-14 parts, and starch nitrate 9-17 parts, the pentaerythritol tetranitrate being in the proportion of 2-12 parts for 2-20 parts of trinitrotoluene and the proportion of

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trinitrotoluene being at least equal to that of the pentaerythritol tetranitrate in the granules of pentolite.

2. An explosive composition as described in claim 1 including granules consisting of sodium nitrate in the proportion of 7.5 to 25 parts for 100 parts of the said composition.

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