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EXPLOSIVE COMPOSITION

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This invention relates to an explosive composition and the method of making it.

More particularly the invention relates to an explosive including, as the base, granules of insensitive explosive material consisting chiefly of ammonium nitrate such as has been sold for some time and has recently been described in U. S. Patent No. 1,992,217 issued to Kirst and Woodbury on February 26, 1935. The base material of such explosives consists largely of ammonium nitrate but may contain admixed sodium nitrate and other materials in minor proportion and is insensitive to the action of a No. 6 blasting cap.

Due to the insensitiveness of explosives of the type described in U. S. Patent No. 1,992,217 containing ammonium nitrate granules as the chief or base ingredient, the explosives have been recommended because of safety in transportation, handling and use. Such explosives are described in the patent as requiring, when unconfined in a column of cross sectional area of at least about 3 square inches and at a density of 1.0, a detonating impulse substantially greater than that from any commercial detonator but not in excess of 1,000 grams of TNT at a density of 0.95. Serious objection has been raised to these explosives, however, because they are not certain of detonation under some conditions of use.

When used with a usual booster charge, such as TNT in amount not in excess of 1,000 grams. in hard rock such as granite, when the containers for the explosives fit properly the drill hole within the rock, and when the containers are carefully aligned and placed end against end, explosives of this type generally give satisfactory results, the detonating impulse from the booster charge being carried completely through the column of explosive. When, however, the same kinds of explosive and containers are used in comparable manner in drill holes in a softer rock formation, such as shale for example, the detonating wave is not always propagated completely through the column of explosive. While those containers of the explosive nearest to the booster charge are detonated with substantially full efficiency, the containers of explosive more remote from the booster charge often fail to detonate.

There are serious objections to such misfire of a part of the explosive charge. In cases where the amount of the charge has been accurately proportioned to the work required of the blast, this failure of a part of the charge to detonate may result in a partial or substantially complete failure of the blast to move the rock properly in front of the drill hole and thus cause considerable annoyance and unnecessary expense. Although the unexploded containers of explosive of the type described in U. S. Patent No. 1,992,217 do not represent any great hazard, because of the relatively insensitive nature of the explosive, the removal of unexploded cans or containers of the explosive from the bank after the blast frequently has an unfavorable effect upon the men working in the quarry. There is an additional loss to the operator in material wasted as the unexploded cans are distorted in shape and broken open and their contents exposed or spilled.

Several methods have been suggested for improving the sensitiveness of explosives of this type. It has been suggested, for example, to admix suitable amounts of nitroaromatic compounds, such, for example, as the nitrotoluenes for the purpose of improving the ability of the explosive to detonate completely through a long column in soft rock formations. It has been suggested, also, to subject explosives of this type to controlled heating operations, as a means of increasing the rate of detonation of the explosives and its ability to propagate explosions completely through the column, without at the same time raising the sensitiveness of the explosive to such a degree that the explosive may be fired by a commercial detonating cap.

Notwithstanding the extensive nature of the efforts which have been made to improve the detonation characteristics of such explosives, so that they can be used in soft rock formations with complete assurance that the detonation of the explosive will be dependable, i. e. complete, in all cases and that cans or containers of the explosive will not be left in unexploded condition in portions of the blast, it has not been possible up to this time to achieve this desired result. By adding suitable amounts of nitroaromatic sensitizers or by controlled heating of the explosive containing a nitroaromatic compound, it has been found possible, it is true, so to modify the explosive that it will completely detonate to the end of the column under all practical conditions; but when this dependability of detonation has been achieved, the explosive is found to be sensitive to commercial blasting caps and accordingly is no longer within the limits of sensitiveness of the type of explosives described in U. S. Patent No. 1,992,217. All efforts to modify the sensitiveness of this type of explosive, so as to produce an explosive that detonates completely through the column with entire depend-

ability in all types of loading such as met with in practice and yet be insensitive to commercial detonating caps have been unsuccessful.

The present invention provides a composition that is dependably detonatable throughout the entire column of explosive by a usual boosting charge even when the explosive is used in well holes in soft rock.

The invention comprises a granular explosive composition including dense ammonium nitrate or ammonium nitrate admixed with minor amounts of other inorganic nitrates and, adhered over the granules, very fine starch nitrate particles in proportion that is of the order of 0.5% to 3% of the whole composition. In the preferred embodiment, the invention comprises the use of a binder material increasing the firmness of bonding of the finely divided starch nitrate to the surface of the particles of the base explosive. The invention includes also the method of making the improved explosive composition.

As the base explosive there is used an inorganic nitrate composition such as described in the said patent to Kirst and Woodbury which may include also a small proportion of paraffin such as 5% or so to impart resistance to wetting by water or other desirable property to the explosive. The inorganic nitrate constituting most at least of the base explosive may include admixed sodium nitrate, say in proportion up to about 20% or so of the combined weight of ammonium and sodium nitrates. The base composition is suitably in the form of dense granules of substantial size, as, for example, 30 mesh or larger, and the granules may be either in loose condition or consolidated, as by compression, into a shape retaining mass.

It is necessary that the starch nitrate used should be in the form of very fine particles. Particularly satisfactory results have been obtained when the starch nitrate is a powder predominantly in the form of particles of longest dimension between 0.0005 and 0.002 inch. When the very fine starch nitrate in the proportions stated is mixed with granules of ammonium nitrate explosive containing absorbed moisture, as my ammonium nitrate does during the mixing stage, the starch nitrate becomes adhered to the said granules.

The proportion of the starch nitrate should be between approximately 0.5 part and 3 parts for 100 parts of the complete explosive composition. If a smaller proportion than about 0.5% is used, there is not obtained dependability of detonation with the usual booster explosive under all circumstances. If, on the other hand, the proportion of the starch nitrate is substantially more than 3%, then there is obtained undesired sensitiveness to explosion. When the starch nitrate is used in the fineness and in proportion within the range stated, the resulting explosive composition is insensitive to a No. 6 blasting cap but can be depended upon to be detonated completely by a booster charge equivalent to not more than 1000 g. of trinitrotoluene when the explosive mixture is in the form of a column of area of cross section of 3 square inches and the booster charge is located in one end of the column.

In view of the known insensitiveness of starch nitrate, as evidenced by the fact that a bullet may be fired at close range into commercial starch nitrate explosives without firing the charge, and particularly in view of the insensitiveness of the starch nitrate as compared with some of the nitroaromatic admixtures that have been proposed for use in the type of explosives described in U. S. Patent No. 1,992,217, it is surprising that the incorporation of the small proportion of starch nitrate serves the present purpose. It is considered that the explanation for the result lies largely in the fine state of subdivision of the starch nitrate powder. When this powder is distributed over the granules of ammonium nitrate explosive, the particles of starch nitrate do not coalesce into a relatively small number of isolated grains but form a thin coating in which the greatest distance between adjacent particles of the coating material is very small and practically infinitesimal. Nitroaromatics and like mixtures, on the other hand, tend to agglomerate and give coatings that are more concentrated in localized positions so that substantial spaces exist between the particles of the sensitizing material. As a result of the practically continuous coating of the starch nitrate powder over the base material, the explosion initiated in one part of the starch nitrate is communicated to other particles of it separated at most by practically infinitesimal spacing from the exploding part.

As a result, many cans of the improved explosive in compressed condition may be placed endwise, one upon another in a drill hole with the assurance that all the cans will explode when the 1,000 gram booster charge of TNT or the like is fired in the top of the column of the cans, even when blasting soft rock or like formations.

The proportion of starch nitrate to be selected within the range 0.5 part to 3 parts for 100 parts of the whole composition depends in part upon the relative degree of insensitiveness of the base explosive selected. The proportion of starch nitrate within this range is larger, for example, with higher proportions of paraffin to ammonium nitrate and larger or more firmly compressed granules of ammonium nitrate in the explosive of the type described in U. S. Patent No. 1,992,217. On the other hand, the proportion of the sensitizing starch nitrate is made relatively small when the base explosive material is in the form of very small granules or the proportion of paraffin is very low.

For best results in maintaining uniformity of distribution of the starch nitrate and avoiding any tendency whatever to segregation as by settling, I prefer to use a binding material to adhere the starch nitrate to the surface of the particles of the base explosive.

As the binding material I may use a lacquer, a resin composition, corn syrup, or like adhesive material. When a lacquer is used, it is suitably one containing pyroxylin dissolved in a volatile solvent and the proportion used is very small. The lacquer is used in such limited proportion, in fact, that the solvent contained is not sufficient to dissolve the starch nitrate which is subsequently introduced. A resin composition that is suitable is one containing a solution of rosin in methyl alcohol, with castor oil added as softener, the proportions of the materials being suitably about 25 parts of rosin, 15 of castor oil, and 60 of methyl alcohol, although the proportions are not critical and solutions of these materials of various proportions may be used. Corn syrup if used is introduced in quantity just sufficient to impart a somewhat sticky na-

ture to the surface of the granules of the ammonium nitrate explosive.

When a volatile solvent is used in applying the binder, the solvent is preferably removed substantially completely by evaporation.

All of these binding agents are suitably applied by spraying upon the ammonium nitrate explosive while the explosive is being tumbled and continuing the tumbling for some time after the spraying has been completed.

Into the composition of the thus coated particles of base explosive, there is introduced the selected proportion of starch nitrate powder, the powder being suitably dusted in slowly as the composition is tumbled so that the powder becomes practically uniformly distributed throughout the entire mass and is bonded by the binding material to the individual particles of ammonium nitrate explosive.

For some purposes it is satisfactory to introduce the starch nitrate in dry condition and then to thoroughly blend it by tumbling with the ammonium nitrate base material also in dry, not adhesively coated condition. In any case, it is required that the method of making the composition include the step of admixing starch nitrate and distributing it over the surfaces of the particles of base explosive so that the starch nitrate adheres to the said particles. It is required also that the granules of ammonium nitrate be of the usual dense kind, so that the small proportion of starch nitrate used is adequate to coat the granules substantially continuously.

The mixture so made is then subjected to usual steps for filling into suitable containers, either before or after compression into form retaining cylinders or other shapes.

Explosives so made are dependably detonatable by booster charges of kind and amount conventionally recommended for use with explosives of the type described in U. S. Patent No. 1,992,217.

It will be understood 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 departures from the spirit and scope of the invention.

What I claim is:

1. An explosive containing as the principal ingredient dense granules of ammonium nitrate, of size at least 30 mesh and requiring, when unconfined in a column of cross sectional area of at least 3 square inches and at a density of 1.0, a detonating impulse substantially greater than that from any commercial detonator but not in excess of 1,000 grams of TNT at a density of 0.95, and as the sole sensitizing agent fine starch nitrate powder, in the form of particles of longest dimension varying from 0.0005 to 0.002 inch, distributed uniformly over the particles of ammonium nitrate, the proportion of the starch nitrate being 0.5 to 3 parts for 100 parts of the explosive composition, the composition described causing the explosive to be cap-insensitive but dependably detonatable by a standard booster charge when the composition is present in a drill hole and the column of explosive composition has a cross sectional area of at least 3 square inches.

2. An explosive composition as described in claim 1 including a lacquer film distributed over the granules of ammonium nitrate and adhering the starch nitrate to the said granules.

3. An explosive composition as described in claim 1 including a film of starch conversion syrup solids distributed over the granules of ammonium nitrate and adhering the starch nitrate to the said granules.

4. The method of making the explosive composition described in claim 1 which comprises applying to the particles of ammonium nitrate a suspension of starch nitrate powder in a solution of a binder in a volatile solvent, the said solution being used in limited amounts and the solvent in proportion less than that adequate to dissolve the starch nitrate, so that the binder bonds the starch nitrate in undissolved condition to the said granules.

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