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REVERSIBLE EXPLOSIVE

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My invention relates to explosives and more particularly to such compositions having particles of extreme fineness, coated or in intimate contact with carbonaceous materials or other combustible materials of extreme fineness or in very thin coating.

It is known that the usual ammonium nitrate explosives, especially those possessed of a high ammonium nitrate content are hygroscopic and, under various atmospheric conditions, have a tendency to "set up" or to solidify into a hardened mass. Depending upon the aqueous tension of the atmosphere and the vapor tension of the components of a mixture, the phenomenon of "setting up" may be accompanied by either an increase or a decrease in apparent density. When the components are in the form of a dynamite cartridge, a shrinkage of the mass usually develops; although a high variation in moisture conditions may induce an appreciable increase in the volume of the mixed components even to the point of causing the cartridge containing them to burst.

In the instance of dynamite containing nitroglycerine or other explosive components the aforesaid alteration of characteristics is causally responsible for the acquisition of a number of extremely undesirable properties by the explosive materials. Among them is the disadvantageous characteristic of a reduced sensitivity by the explosive to detonation by the customary commercial blasting caps—an insensitivity that not infrequently results in a complete failure to detonate. Furthermore, the undesirable, new properties increase the hazards of using, handling and transporting the dynamite because a segregation of the nitroglycerine in interstices or pockets throughout the cartridge may result from this phenomenon of "setting up." Consequently, the increased hazard of handling the "set up" material makes the danger of breaking up such hardened cartridges for reworking purposes almost prohibitive. For, cartridges that have been thus altered cannot be conveniently freed of their excess in moisture content in view of the inherent risk that must be involved in drying the pockets of the segregated nitroglycerine as well.

Although the aforesaid phenomena are not unknown in the explosives art, yet obviously it has been the objective heretofore to avoid as far as possible the use of cartridges of dynamite that have become solidified or that have otherwise acquired undesirable properties.

One of the objects of my invention is not only to apply usefully a phenomenon that has been

previously a source of difficulty to the industry; but, under other conditions than those of excessive moisture surroundings, I actually seek to harden sticks or pellets of explosives by subjecting them to extremely high pressures. In executing my intentional method of pressing explosives into hardened pellets or forms, I select only those compositions which prior to packing or pressing are relatively insensitive to friction, heat and impact as compared with the regular grades of dynamite and particularly those that are made explosive by the use of explosive sensitizers. In the operation of "setting up" the customary grades of dynamite, the reduced sensitivity that ensues is owing substantially to the destruction of the necessary, uniform and continuous film of nitroglycerine that should surround the many particles and to the increased density of the mass which in itself becomes a direct cause of an insensitivity to detonation by a conventional blasting cap. If insensitive explosives, consisting of mixtures of non-explosive material, or of explosives, or of both are properly selected for the subsequent high pressure treatment that results in an increased density, then the obvious hazards that would be normally encountered in such a procedure are entirely eliminated.

When the usual or customary grades of dynamite become "set up" either designedly or unintentionally, their reduced sensitivity because of the segregation of nitroglycerine and their increased density render them unreliably responsive to a conventional blasting cap and generally unsatisfactory for explosive purposes. It is another object of my invention to select and to develop such compositions of explosives that will comply under conditions of control with the requirements that have been partly and will be more fully set forth. One of the most important compositions in this category consists of 90% or more of ammonium nitrate that is intimately incorporated with combustibles of various kinds. Although compositions of such a type are specifically mentioned and preferred, yet my invention encompasses all compositions that can be exploded by a commercial blasting cap and that are relatively insensitive to impact, flame and friction. In finely-powdered mixtures, in which the particle size approximates colloidal dimensions and particularly in those mixtures that can be readily shot with a commercial No. 6 or 8 blasting cap at a density of 1.0 or less and in some instances at densities up to 1.25 depending upon the composition and the intimacy of aggre-

gation, such compositions can become pressed at high pressures into pellets (or sticks, blocks, balls and cylinders) that acquire densities as high as 1.6 or 1.7. However, in many compositions pressures are necessary to yield a density of only 1.35 to reduce the sensitivity of the composition to a level at which the conventional No. 6 or 8 cap will not produce detonation.

My investigations have disclosed that combinations of ammonium nitrate and combustible materials, must, in general, be of a high degree of fineness and intimacy of contact in order that they may be detonated by a No. 6 or 8 cap, even though the components of the composition are loosely packed at fairly low densities. For many compositions a criterion of desirable fineness is achieved by passing the bulk of the pulverized materials through a 100 and preferably a 200 mesh screen and a large proportion through a 300 mesh screen. Nevertheless, it is not always imperative to prepare the mixture before pressing it into pellets, in such a condition of granulation and intimacy that it will always explode by the use of a commercial blasting cap. The application of high pressure to various compositions to form high density pellets causes a definite crushing and comminution of the component constituents into smaller particles and establishes such a consolidation of the numerous grains of the materials that is not necessary to produce previously the high degree of fineness and intimacy of contact that is ordinarily prerequisite to detonation by a No. 6 or 8 cap.

Although it is well known to the explosive industry that certain explosive compounds and mixtures are insensitive to detonation by commercial caps at high density, yet the application of this property in conjunction with several other steps in my procedure has been unknown to and never utilized by the investigators and the producers in the field.

Hence, it becomes an important purpose of my invention to produce first an explosive composition; secondly, to render it non-explosive by either increasing its density directly or by subjecting it to the other treatments previously mentioned and, thirdly, to restore to the dense pellets their original explosive properties by reducing them to an intermediate or the initial density.

The choice of an explosive composition covers a wide range. However, compositions of intimate mixtures of ammonium nitrate and combustible materials are preferred. The latter substances are the usual carbonaceous materials such as coal, rosin, oil, carbon in its various forms or any of the carbon compounds or mixtures in common or special use. In addition to the combustible carbonaceous materials, I submit substances such as aluminum, magnesium and other finely divided metals; the nitrated hydrocarbons such as di-nitro-toluene and di-nitro-benzene; even some of the relatively insensitive explosives (TNT or picric acid); and, in fact, any materials that are not in themselves explosive. The preparation of the initial explosive composition involves a critical regard for the fineness of the constituent particles in accordance with the specifications previously described and for their intimacy of association in the mixture. Compositions thus prepared are ordinarily sensitive to a commercial blasting cap, although it is not wholly essential to observe strictly the requirements of grinding and mixing if the application of a subsequent high pressure compensates for the lack of initial thoroughness.

After the compositions have been prepared, the step of transforming them into non-explosive pellets, sticks, blocks, cylinders, etc., is then undertaken. Various methods, such as the application of high pressure or the induction of the "setting up" phenomena or any other means, may be employed. The pellets that are thus formed possess a high density—a property that renders them insensitive to the usual commercial blasting cap and definitely removes them from the class of explosives. Since the non-explosive pellets are entirely safe and innocuous, it becomes entirely unnecessary to comply with the explosive regulations in so far as their transportation, storage and handling are concerned. Furthermore, the original composition, as a pellet, can resist the absorption of moisture with a greatly increased effectiveness. The pellets can also be easily coated or otherwise surface-treated to render them water proof. As a consequence, the pellets can be transported from producer to consumer as ordinary heavy chemicals with the resulting economies that attend low freight rates and inexpensive packaging. Should the pellets for any reason absorb moisture beyond the limits required for a satisfactory, finished product, they can be readily dried before grinding them into an explosive form or condition.

When the pellets have been shipped to the consumer or to any other convenient location, they are crushed and pulverized to the required fineness, are packed in suitable containers and then become a safe explosive characterized with a greatly reduced sensitivity to impact, flame and friction. The method of crushing and grinding the pellets necessarily depends upon the composition that was used and the density to be desired. The most important function of grinding is to achieve the fineness of particles that is necessary to establish a sensitivity to detonation of the particular composition. It is well known that a mixture of fine and coarse grains will produce an explosive of high density. A given composition of only coarse grains has a low velocity of detonation; a given composition of only fine grains has a high velocity of detonation; and a mixture of coarse and fine grains gives an intermediate velocity of detonation. Although in the case of certain mixtures, such as ammonium nitrate and coal, it is mandatory that a fineness of particle approaching colloidal dimensions be realized in order that the mixture will explode by means of a No. 6 or 8 cap, yet it is not necessary to achieve such a fineness of the component particles of the composition prior to its transformation into pellets.

The novel and utile features of my invention become obvious when one contemplates that by its application virtually all of the hazards that have been identified with explosives become eliminated, since the potential explosive is handled, transported and stored throughout most of its life as a non-explosive material. Furthermore, my compositions at high density and in pellet form can be easily water proofed to resist or to prevent the absorption of water. The non-explosive pellets can be shipped as a heavy chemical at a fraction of the transportation charges imposed upon explosives. In manufacturing explosives in accordance with my invention, a central plant can readily supply sub-plants at great distances with the non-explosive pellets—an advantage that is unrealizable in the shipments of ordinary explosives. Lastly, expensive containers, such as boxes, can be dis-

pensed with; and the storage of large quantities of explosives can be avoided since the pellets can be crushed and ground into an explosive form or condition in such quantities as are needed at any one time or can be most economically handled.

While the processes and the materials as described and exemplified are the preferred embodiment of my invention, nevertheless the same may be modified in detail without departing from the spirit and the scope of my invention as defined in the annexed claims.

I claim:

1. A method of producing an explosive mixture comprising, first, intimately mixing NH_4NO_3 and combustibles consisting of particles approaching colloidal dimensions and capable at

low density of detonation by a No. 6 or 8 cap; secondly, compressing said NH_4NO_3 and combustibles into a non-explosive (to a No. 6 or 8 cap) mass, and, thirdly, crushing said non-explosive mass into a mixture detonatable by a No. 6 or 8 cap.

2. A non-explosive (to a No. 6 or 8 cap) and compressed mass of high density, prepared by intimately mixing NH_4NO_3 and combustible particles, said particles approaching colloidal fineness and capable at low density of detonation by a No. 6 or 8 cap, and by compressing said particles into a non-explosive mass; said non-explosive mass adapted to be crushed whereby it is detonatable by a No. 6 or 8 cap.

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