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AMMONIUM NITRATE EXPLOSIVE

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FIG. 1.

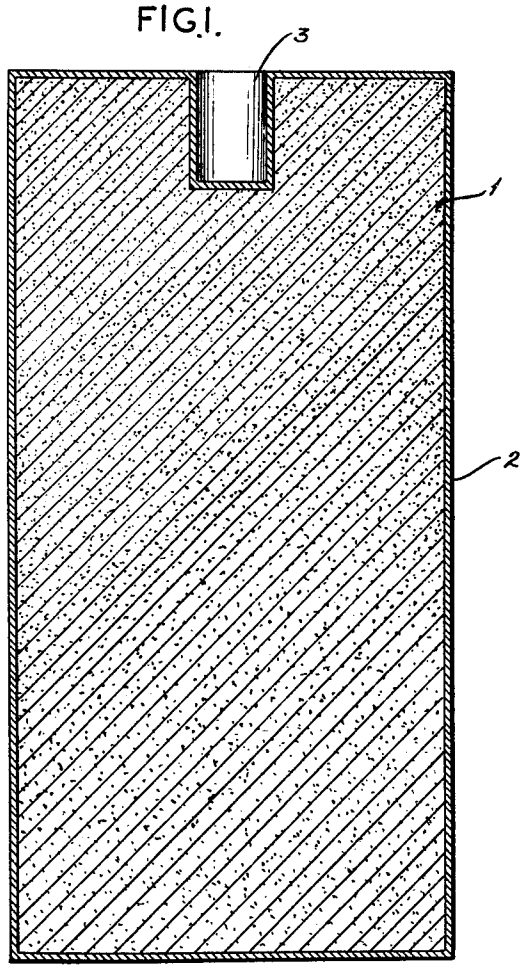
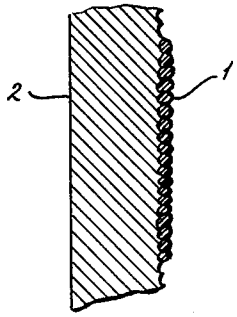


FIG. 2.



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AMMONIUM NITRATE EXPLOSIVE

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8 Claims. (Cl. 102—24)

This invention relates generally to explosives and more particularly to a novel and improved waterproof ammonium nitrate cartridge.

Ammonium nitrate is hygroscopic and readily dissolves in water. During manufacture, storage and shipment, ammonium nitrate has a tendency to absorb moisture and, consequently, becomes less sensitive to detonation because of its increased moisture content. Moreover, when ammonium nitrate explosives are used in wet bore holes, they rapidly absorb water and in some cases become liquid with an attendant reduction in sensitivity.

Ordinarily, ammonium nitrate explosives are packed in cardboard containers. Many attempts have been made to waterproof the paper cartridge by coating it with wax or by providing it with a liner of rubber or a synthetic resinous material. It has also been proposed to pack the explosive in plastic bags, such as bags formed from a film of regenerated cellulose. Such containers are expensive, add bulk to the cartridge, and are easily broken during handling thus destroying the waterproof characteristic of the cartridge. Moreover, the ammonium nitrate is packed in such containers in loose granular form and it is sometimes very difficult to propagate the explosive throughout the length of the cartridge.

It is, therefore, an object of this invention to provide an improved ammonium nitrate cartridge. Another object of the invention is to provide a novel waterproof ammonium nitrate cartridge having an improved sensitivity to detonation. Still another object of the invention is to provide an ammonium nitrate cartridge adapted to be assembled into a rigid column of a series of cartridges in end to end abutting relationship. A further object of the invention is to provide a process for making a waterproof ammonium nitrate cartridge having improved rigidity and improved explosive characteristics.

Other objects will become apparent from the following description when taken in connection with the accompanying drawing in which:

Figure 1 is a longitudinal sectional view of an embodiment of the cartridge provided by this invention; and

Figure 2 is an enlarged view of a portion of the cartridge of Figure 1.

The foregoing objects are accomplished in accordance with this invention, generally speaking, by providing a cohesive block of ammonium nitrate explosive having a density of at least about 1.1 grams per cubic centimeter and preferably from about 1.1 grams to about 1.5 grams per cubic centimeter. In order to provide a cartridge having optimum water resistance, the cartridge is enclosed in an adherent, pliant, snugly fitting protective coating of a waterproofing film. The ammonium nitrate granules used for forming the cohesive block must have particles of a suitable binder clinging to the surface in order to provide a block of explosive that will not crumble or break up in ordinary handling. The granules must, also, have from about 3 to about 7 percent sensitizer clinging to the surface thereof in order to produce an ammonium nitrate explosive having a sensitivity such that an explosion will

be propagated throughout the length of the cohesive block. In practicing the invention, from about 80 percent to about 96 percent by weight ammonium nitrate having a granulation such that it passes through a 12 mesh standard Tyler screen is mixed with from about 3 to about 7 percent of a sensitizer and from about 1 to about 3 percent binder until the particles of the sensitizer and binder are distributed substantially uniformly throughout the ammonium nitrate mass and cling to the surface of the granules. Sodium nitrate, potassium nitrate or other suitable material may be mixed with the ammonium nitrate when it is desired to produce an ammonium nitrate explosive having a strength equivalent to that of the lower strength dynamite such as, for example, a dynamite having a strength of 60 percent of that of pure nitroglycerine, as determined in the Ballistic Mortar test. These materials are used where the ammonium nitrate is within the range of from about 80 percent to about 96 percent of the total cohesive block and wil be used in amounts of not more than about 16 percent. The granulation of the ammonium nitrate and other materials should not be substantially greater than 12 mesh and is preferably 20 mesh or less. The mixing is achieved by stirring the three materials together while at an elevated temperature and, if trinitrotoluene is used as the sensitizer, the temperature is somewhat above the melting point of the trinitrotoluene. Mixing at a temperature within the range of about 80° C. to about 95° C. has been found particularly advantageous. The best results are obtained in pressing the resulting explosive by subjecting it to a pressure of about 200 pounds per square inch or more while the mixture is at a temperature of about 80° C. to about 95° C. It was found that a block compressed to this density and not coated with a resinous material, unlike previously available ammonium nitrate cartridges, could be placed under water for as long at 35 minutes before sufficient water was absorbed to soften the block. By coating the block with the adherent film of waterproofing material the waterproofing characteristic of the block is even further enhanced and, furthermore, the resulting block is more resistant to the absorption of moisture vapor from the air.

The cohesive block of ammonium nitrate explosive having a density of from about 1.1 to about 1.5 grams per cubic centimeter is also substantially resistant to moisture vapor absorption without any protective coating. In order for the protective coating to materially improve the moisture vapor and waterproofing characteristics of the block, it must form a pliable adherent film on the surface of the block without appreciable migration of the coating into the cohesive block. A coating in the neighborhood of from about 0.008 to 0.015 inch in thickness has been found particularly well suited for the purpose. The protective coating is preferably a film of resinous material but it may also be a film of wax such as paraffin, a lacquer, varnish, drying oil such as, for example, China-wood oil, oiticica oil, linseed oil, or other suitable waterproofing material that will form a continuous film over the surface of the block. The coating may be applied by any suitable means such as by dipping the cohesive block into a solution of the waterproofing material or by spraying or by brushing the block therewith. The resinous film may be obtained by coating the cohesive block of ammonium nitrate explosive with a solution of from about 10 to about 15 percent nitrocellulose, from about 10 to about 15 percent polyvinyl acetate-polyvinyl chloride copolymer and about 3 to about 6 percent plasticizer for the nitrocellulose dissolved in from 70 to 80 percent volatile solvent. The plasticizer may be diethyl phthalate, dibutyl phthalate, tricresyl phosphate or any other suitable plasticizer for nitrocellulose. The volatile solvent must be of such a

composition that the coating will dry very slowly without fracturing, but at the same time it must be sufficiently volatile that the coating will dry without material penetration of the cohesive block. The coating fills the interstices between the granules on the surface of the block but must not migrate to any substantial extent into the block. A mixture of about 2 parts ethyl acetate and 1 part benzene has been found particularly well suited for the purpose but other volatile solvents having a vapor pressure substantially equivalent to that of such a mixture may be utilized. Other solvents for nitrocellulose which are suitable for the purpose include methyl ethyl ketone, acetone and the like combined with suitable diluents such as benzene, toluene, mineral spirits and the like to adjust the vapor pressure of the liquid phase of the lacquer within the range required to bring about the proper drying time. Other resins, such as, for example, a polyamide, ethyl cellulose, cellulose acetate, or the like, properly plasticized and dissolved in solvents which will evaporate from the film after the coating is applied to the surface of the block without appreciable penetration of the block, may be utilized.

As indicated hereinbefore the ammonium nitrate explosive composition must contain a binder in order to produce a cohesive block that will not crumble, that is substantially waterproof itself and is suitable for further waterproofing by coating it with an adherent resinous film or other waterproofing material. Examples of such binders include starch, dextrin, synthetic hydrophilic gums methyl cellulose and the like. Such binders when in contact with water begin to swell and fill any interstices between the ammonium nitrate granules on the surface of the cohesive block and tend to prevent further absorption of moisture.

In order better to describe and further clarify the invention, the following is a detailed description of one embodiment with reference to the accompanying drawing.

A cohesive block **1** of about 92 parts granular ammonium nitrate, about 7 parts trinitrotoluene and about 1 part starch compressed to a density of about 1.2 grams per cubic centimeter is illustrated in Figure 1. Block **1** is coated with a film **2** of about 48 parts nitrocellulose, about 48 parts polyvinyl acetatechloride copolymer and about 4 parts diethyl phthalate. A well **3** is centrally located in the top of block **1** and has a coating of the resinous film. The resinous film is about 0.010 inch thick.

In preparing a cartridge of the type illustrated in the drawing about 92 parts granular ammonium nitrate is mixed with about 7 parts trinitrotoluene and about 1 part starch in any suitable vessel equipped with an agitator. A Baker-Perkins mixer having rotating agitator blades has been found particularly well suited for the purpose but mixing may be achieved in any other suitable apparatus such as a ball mill, tumbling barrel and the like. The mass is mixed at a temperature above the melting point of trinitrotoluene. The three materials are agitated together until the particles of trinitrotoluene and binder are substantially uniformly dispersed throughout the mixture and cling to the surface of the ammonium nitrate granules. The mass is then compressed while still warm and preferably while in the range of about 80° to 95° C. under a pressure of about 200 pounds per square inch or at any other pressure suitable for compressing the mass to a density of from about 1.1 to about 1.3 grams per cubic centimeter. The mass is compressed in a suitable die, and means may be provided for forming a well in one end of the block such as well **3**, illustrated in the drawing, adapted to house a plastic cap.

The cohesive block is coated with sufficient solution of about 12 parts nitrocellulose, about 12 parts polyvinyl acetate-polyvinyl chloride and 4 parts diethyl phthalate dissolved in about 50 parts ethyl acetate and 22 parts benzene to produce a film of about 0.010 inch thickness after the solvent has been removed. The cartridge is then air-dried to remove all of the benzene and ethyl acetate and until a pliable, tough, dry film is produced on the cartridge. The resulting cartridge is completely enclosed in an adherent waterproof film which does not migrate into the cohesive block but tightly encloses the same. As illustrated, in Figure 2, the film fills any interstices on the surface of the block forming a series of rather short protuberances which tend to anchor the coating to the block.

When it is desired to use a plurality of the cartridges in series in end to end abutting relationship, a booster charge may be placed between the cartridges to insure propagation throughout the column, although this is not ordinarily required because the length of explosive of column per unit weight of explosive is much less than a column of similar weight loosely packed cartridges. Any suitable booster charge, such as one composed of tetryl, trinitrotoluene or the like, may be utilized. Cartridges in which a booster charge is embedded in the well **3** are also contemplated. Sensitizers for the ammonium nitrate such as, for example, powdered aluminum, asphalt, kerosene, powdered magnesium, dinitrotoluene, pentalrythitoltetranitrate, tetryl, cyclonite, and the like, may be utilized in some embodiments, if desired, instead of trinitrotoluene or in mixtures therewith.

Because of the density of the cohesive block and because of the presence of the binder on the ammonium nitrate granules, the block is substantially resistant to moisture even without the protective coating so the cartridge retains substantial moistureproofness even if the coating is accidentally fractured during handling. Since the film is relatively pliable and fits snugly about the block, however, fracture of the film due to abrasion is unlikely and will occur very infrequently with normal handling. Since the coating is adherent and tightly encloses the cohesive block forming a more or less unitary structure, the cartridges may be assembled into a rigid column of a series of explosive cartridges which is particularly advantageous for charging deep, wet bore holes.

The cohesive block of ammonium nitrate explosive occupies less space per unit of weight than the heretofore loosely packed cartridges which is advantageous because the cartridges occupy less space in the bore hole. Consequently, fewer holes are required when larger quantities of explosive are used per shot and because of the shorter column of explosive, less priming is required. It is also possible to concentrate a larger quantity of explosive in the bottom of the hole where it will be most effective.

The cohesive block of ammonium nitrate explosive may be provided with a cavitated end in order to further improve the propagation of the explosion from one block to the other when a column is formed from a series of the blocks. The cavitated blocks permit taking advantage of the well-known "Munroe effect" or, in other words, permit direction of the explosive effect in the form of an explosive jet from one block to the other. The shape of the concave surface may vary from conical to hemispherical or hemispheroidal shape or any other shape suitable for producing an explosive jet for detonating an adjacent block of explosive. By providing the cavitated dense cohesive block less Primacord or other initiating explosive will be required to insure propagation of the explosive throughout a column of the ammonium nitrate blocks.

Although an embodiment of the invention has been described in considerable detail for the purpose of illustration, it is to be understood that such detail is solely for the purpose of illustration and that many modifications may be made by those skilled in the art without departing from the spirit and scope of the invention except as it is limited by the appended claims.

I claim:

1. A self-contained explosive cartridge having two substantially parallel ends and comprising a cohesive consolidated explosive charge consisting essentially of from about 90 percent to about 96 percent by weight granular ammonium nitrate having from about 3 percent to about

7 percent trinitrotoluene and from about 1 percent to about 3 percent binder clinging to the surface of the granules, said charge having a density of from about 1.1 grams per cubic centimeter to about 1.3 grams per cubic centimeter, and an adherent protective coating on the charge consisting essentially of from about 40 percent to about 57 percent polyvinyl acetate-polyvinyl chloride copolymer, about 40 percent to about 50 percent gelatinized nitrocellulose and from about 3 percent to about 6 percent plasticizer for the nitrocellulose.

2. The cartridge of claim 1 wherein said binder is starch.

3. The cartridge of claim 1 wherein said binder is dextrin.

4. The cartridge of claim 1 wherein the binder is a synthetic hydrophilic gum.

5. The cartridge of claim 1 having a well in one end thereof adapted to receive an initiating means.

6. The cartridge of claim 1 wherein the coating is about 0.010 inch in thickness.

7. The cartridge of claim 1 wherein the plasticizer is diethyl phthalate.

8. A self-contained explosive cartridge having two substantially parallel ends and comprising a cohesive consolidated explosive charge consisting essentially of from about 90 percent to about 96 percent by weight of ammonium nitrate granules sufficiently small to pass through a 12 mesh standard screen, the granules being

intimately mixed and having adherent to the surface thereof from about 3 percent to about 7 percent trinitrotoluene solidified in situ and from about 1 percent to about 3 percent binder, said charge having a density of from about 1.1 to about 1.5 grams per cubic centimeter and an adherent pliable waterproof coating consisting essentially of from about 40 percent to about 57 percent polyvinyl acetate-polyvinyl chloride copolymer, about 40 percent to about 50 percent gelatinized nitrocellulose, and from about 3 percent to about 6 percent plasticizer for the nitrocellulose, said coating filling the interstices between the ammonium nitrate granules on the surface of the explosive charge.

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