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## 3,377,217 GELLED AMMONIUM NITRATE-NITROMETHANE EXPLOSIVE COMPOSITION

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No Drawing. Filed Dec. 12, 1966, Ser. No. 600,710  
6 Claims. (Cl. 149—50)

### ABSTRACT OF THE DISCLOSURE

Gelled non-cap-sensitive explosive compositions consisting of an intimate admixture of ammonium nitrate of particle size sufficiently small to substantially completely pass through a 10 mesh screen, not more than 22% by weight of the ammonium nitrate passing a 200 mesh screen, nitromethane and gelling agent for the nitromethane, the weight ratio of ammonium nitrate to nitromethane being in the range of from about 65:35 to about 45:55, said compositions having high detonation rates. The explosive compositions are useful in seismic exploration for oil and gas.

This invention relates to explosive compositions containing ammonium nitrate and nitromethane. In a particular aspect this invention relates to non-cap-sensitive explosive compositions, in gelled form having high rates of detonation. In a further aspect this invention relates to non-cap-sensitive explosive compositions in gelled form having high rates of detonation useful in the seismic exploration for oil and natural gas found beneath the ocean floor.

Explosives are used in the seismic exploration for oil and gas deposits found beneath the ocean floor. Energy from shock waves produced by the detonation of explosives beneath the surface of the water travels downward to beneath the ocean floor and is then partially reflected upward. The energy returning to the surface is picked up by a receiving apparatus known as a geophone which in turn transmits the received impulses to amplifying and recording devices. Interpretation of the recorded information permits the skilled geophysicist to determine geological structures where oil and natural gas are likely to have accumulated.

Explosive compositions used in marine seismic petroleum exploration desirably have high rates of detonation. Because of the stringent safety requirements in major ports regarding the loading of explosives on ocean going vessels, such explosives must also be non-cap-sensitive; that is, incapable of detonation by a single No. 8 electric blasting cap.

Explosive compositions in gelled form comprising ammonium nitrate, nitroparaffins such as nitromethane, nitroethane and nitropropane and a gelling agent for the nitroparaffin are known to the art and have a wide variety of applications. Prior explosive compositions containing ammonium nitrate and nitroparaffins in gelled form have not been suitable for use in marine seismic exploration because of failure of the compositions to meet the requirements outlined above.

It is an object of the present invention to provide non-cap-sensitive explosive compositions in gelled form having high rates of detonation containing ammonium nitrate and nitromethane.

It is a further object of the present invention to provide non-cap-sensitive explosive compositions in gelled form having high rates of detonation useful in marine seismic exploration for oil and natural gas.

Other objects and advantages of the present invention

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will be apparent from the specification and appended claims.

The present invention resides in the discovery that non-cap-sensitive explosive compositions having high rates of detonation are prepared by forming an intimate admixture of ammonium nitrate of particle size sufficiently small to substantially completely pass through a 10 mesh screen with not more than 22% passing through a 200 mesh screen, nitromethane, and a gelling agent for the nitromethane wherein the weight ratio of ammonium nitrate to nitromethane is in the range of from about 65:35 to about 45:55.

In the present application the terms "rate of detonation" and "detonation rate" are used interchangeably with the term "detonation velocity." The rate of detonation of an explosive is the rate at which the detonation front passes through the explosive material. Detonation rate is typically expressed in feet per second. For the purpose of the present invention high detonation rates are generally considered to be in excess of 12,000 feet per second. The compositions of the present invention have detonation rates in excess of 18,000 feet per second with detonation rates of in excess of 20,000 feet per second being reasonably common in freshly prepared material; that is, material prepared within the most recent 24-hour period.

Any suitable gelling agent for thickening or gelling the normally liquid nitromethane may be employed in the compositions of the present invention. Examples of such gelling agents include nitrocellulose, ethyl cellulose, cellulose acetate, cellulose acetate butyrate, polyoxyethylene having molecular weights in the range of from about one hundred thousand to about five million and the like. Because of the excellent results obtained therewith, nitrocellulose is preferred as the gelling agent.

The amount of gelling agent suitable for use in the explosive compositions of the present invention will vary depending principally on the particular gelling agent employed and on the viscosity desired for each particular composition. Typically, amounts in the range of from about 2 to about 15% by weight of gelling agent based on the weight of the nitromethane are employed. Preferred amounts are in the range of from about 5 to about 10% by weight.

The weight ratio of ammonium nitrate to nitromethane is a critical feature of the present invention and, as previously stated, must be in the range of from about 65:35 to about 45:55. Preferably the weight ratio of ammonium nitrate to nitromethane is about 60:40.

The particle size of the ammonium nitrate is also a critical feature of the present invention and, as previously stated, the ammonium nitrate must be of particle size sufficient to substantially completely pass through a 10 mesh screen with not more than 22% by weight passing through a 200 mesh screen. The particle size distribution is preferably as follows:

| Screen Size<br>(U.S. Sieve Series) | Percentage |         |
|------------------------------------|------------|---------|
|                                    | Minimum    | Maximum |
| +10                                | 0          | 0       |
| -10+35                             | 0          | 10      |
| -35+60                             | 0          | 40      |
| -60+100                            | 0          | 30      |
| -100+200                           | 10         | 22      |
| -200+Pan                           | 15         | 22      |

Any suitable form of ammonium nitrate may be used in the compositions of the present invention provided, of course, the particle size limitation is observed. Fertilizer grade and explosive grade ammonium nitrate are suitable. For example, granular ammonium nitrate and ground ammonium nitrate prills may be employed. The ammonium nitrate may be coated or uncoated. Coatings

for ammonium nitrate are well known to the art and include diatomaceous earth, wax, kaolin clay and the like.

The explosive compositions of the present invention are readily prepared by forming an intimate admixture of ammonium nitrate, nitromethane and gelling agent in the amounts and ratios set forth above. The mixing may be carried out by any suitable procedure using mixing equipment suitable for mixing the ingredients. The intimate admixtures have the consistency of heavy doughs and may be termed "gels." The compositions may be formed by first mixing the nitromethane and gelling agent to form a thickened or gelled nitromethane composition and subsequently mixing the gelled composition with the ammonium nitrate. As an alternate procedure, the ammonium nitrate, nitromethane and gelling agent may be placed in mixing equipment and mixed in a one-step operation.

By way of example, 600 lbs. of ground ammonium nitrate of particle size sufficiently small to substantially completely pass through a 10 mesh screen with not more than 22% passing through a 200 mesh screen prepared by grinding fertilizer grade, high density, ammonium nitrate prills, 400 lbs. of nitromethane and 20 lbs. of nitrocellulose are placed in a mixing machine and the mixer is operated until an intimate admixture is formed. After thorough mixing the admixture may be packaged in desired quantities. By way of example, the mixture is passed to a hopper and there fed in 50 lb. quantities or other quantities into appropriately sized water resistant containers. The loaded container is then equipped with a detonating device, as for example, a primer, of sufficient power to detonate the explosive composition contained therein. The containers can be formed of any suitable container material. Waterproof or water resistant containers are naturally preferred. Typical container materials include polyethylene, polyvinyl chloride, polystyrene, fibrous materials such as wood, paper and cardboard; ferrous metals and non-ferrous metals such as tin, copper and aluminum. The packaged explosive composition is suitable for detonation under water in the seismic exploration for oil and natural gas. The packaged explosive composition has a detonation rate of in excess of 18,000 feet per second and is non-cap-sensitive.

From the foregoing those skilled in the art should readily understand that the present invention provides

explosive compositions which are well adapted for uses requiring non-cap-sensitive gelled explosive compositions having high rates of detonation.

Since many embodiments of this invention may be made and since many changes may be made in the embodiments described, the foregoing is to be interpreted as illustrative only and the invention is defined by the claims appended hereto.

I claim:

1. A non-cap-sensitive explosive composition in gelled form having a high detonation rate consisting essentially of an intimate admixture of ammonium nitrate of particle size sufficiently small to substantially completely pass through a 10 mesh screen, not more than 22% by weight of said ammonium nitrate passing a 200 mesh screen, nitromethane and gelling agent for the nitromethane being in the range of from about 65:35 to about 45:55, and the amount of gelling agent being sufficient to effectively thicken said mixture.

2. The composition of claim 1 wherein the weight ratio of ammonium nitrate to nitromethane is about 60:40.

3. The composition of claim 1 wherein the amount of gelling agent is in the range of from about 2 to about 15% by weight based on the weight of the nitromethane.

4. The composition of claim 1 wherein the amount of gelling agent is in the range of from about 5 to about 10% by weight based on the weight of the nitromethane.

5. The composition of claim 1 wherein the gelling agent is nitrocellulose.

6. The composition of claim 1 wherein the ammonium nitrate is of particle size distribution to be partially retained on screens 35, 60 and 100 mesh.

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