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3,095,335
BLASTING AGENT OF MULTI-SIZED AND MULTI-DENSITY AMMONIUM NITRATE WITH FUEL OIL
Don B. McCloud and Dean E. Albon, Du Quoin, Ill., assignors to Airmite-Midwest Incorporated, a corporation of Illinois
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This invention relates generally to a blasting-agent mixture and method of making the same, and is especially concerned with blasting-agent mixtures containing prilled fertilizer-grade ammonium nitrate.

While the mixture of the instant invention is explosive in its broad sense, the preferred embodiment disclosed hereinafter is technically more accurately termed a "blasting agent," which is distinguished from an "explosive" in the narrow sense of the latter term by being non-cap-sensitive (incapable of being detonated with a single No. 8 blasting cap) and not subject to the stringent rules applying to the manufacture, transportation, storage, and handling of "explosives."

As is well-known, fertilizer grade of ammonium nitrate has come into wide use in recent years as a blasting agent, especially in the coal-stripping industry, its popularity being due primarily to relatively low cost. The primary mode of use has been that of fertilizer-grade coated prills mixed with fuel oil. The prills are relatively porous having relatively low density of between .70 and .90, averaging about .82, and are highly hygroscopic, so as to be commonly coated to prevent the absorption of water, as with between 2% and 6% diatomaceous earth. The densities referred to herein are bulk densities as encountered in practical usage. Due to the relatively low density of the agricultural or fertilizer-grade ammonium-nitrate prills, the rate of detonation seldom exceeds 11,000 feet per second; which is insufficient velocity for many blasting purposes without closer spacing of the blastholes, which adds substantially to the drilling costs.

Another disadvantage inherent in the prior usage of fertilizer-grade ammonium-nitrate prills as a blasting agent was the difficulty or impossibility of loading water-filled blastholes. That is, the relatively low density of the mixture of fertilizer-grade ammonium nitrate and oil prevented its sinking to the bottom of such holes, and required the use of weights and similar devices in cartridges filled with the blasting mixture to insure that the cartridge would sink in water. Of course, these expedients substantially reduced the blasting efficiency of such cartridges. By the teachings of the instant invention a fertilizer-grade ammonium-nitrate mixture is obtained having a density greater than unity to insure its sinking to the bottom of water-filled blastholes, without the need for weights or the like, to considerably enhance the resultant efficiency and blasting effect.

As substantially all fertilizer-grade ammonium-nitrate prills have in the past been coated, as mentioned hereinbefore, to prevent agglomeration or caking due to the absorption of moisture, these relatively low-density porous prills will be referred to hereinafter as "coated prills." Commonly the coated prills are of a spherical configuration and size to pass through a 10-mesh screen and be retained on a 20-mesh screen.

By recent manufacturing advances there have been produced fertilizer-grade ammonium-nitrate prills of relatively high density, between .90 and 1.1 and averaging about 1.0. These high-density ammonium-nitrate prills have heretofore been considered unusable for explosive purposes, being of a relatively dense, crystalline structure and having a smooth, glasslike surface so as to be incapable of absorbing sufficient oil for proper explosion.

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These relatively dense, and hence nonporous fertilizer-grade prills will be referred to hereinafter as "uncoated prills."

While increased density of ammonium nitrate up to about 1.5 is conducive to increased rate of detonation or detonation velocity, it is essential that sufficient fuel oil be intimately contained in the mixture to support the reaction. The relatively dense uncoated prills were considered unusable in explosives as being insufficiently porous to absorb the required fuel oil. An important part of the instant invention resides in the discovery that upon pulverizing the relatively dense uncoated prills, the resultant powder or particles adsorb sufficient fuel oil to give proper explosive action. However, mere pulverization of the uncoated prills and mixture with fuel oil is unsatisfactory, as by the hygroscopic nature of the pulverized material it very soon cakes and forms a solid mass.

While the caking could be reduced by mixture with a considerable percentage of conditioner, such as diatomaceous earth or other inert powdered material, this adversely affects the explosive qualities and considerably reduces the detonation velocity. Another important discovery contributing to the success of the instant invention is that when the pulverized uncoated prills are mixed with coated prills and oil such mixture will not cake or harden, but remain loose and free-running during long periods of storage.

The method and resultant mixture of the instant invention produces a blasting agent of substantial density, approximating 1.1 so as to sink in water for blasting wet holes, and which has a very high velocity of detonation greater than 14,000 feet per second due principally to its relatively high density.

The instant invention utilizes both the coated and uncoated prills of fertilizer-grade ammonium nitrate. Stated generally, a quantity of coated prills is first mixed with oil, and a quantity of the uncoated prills is pulverized and the resultant powder immediately mixed with the coated prills and oil. Mechanically, this resultant mixture is relatively dense, as the powdered ammonium nitrate fills the voids between the prilled ammonium nitrate and increases the bulk density of the mixture to 1.1 in contrast to a bulk density of only .82 which obtained in all fertilizer-grade prill-oil mixtures used heretofore. The mixture is preferably vibrated to assume its maximum bulk density.

More specifically, the uncoated relatively dense prills are ground to an approximate screen analysis as follows:

Screen Size (Tyler Mesh)	Total Percentage	
	On	Passing
14.....	00	100
20.....	2.5	97.5
28.....	15.8	84.2
35.....	38.9	61.1
48.....	56.6	43.4
100.....	78.2	21.8
200.....	89.8	10.2

Thus, it is seen that the powdered high-density ammonium nitrate is of various-size particles, all of the particles passing through a 14-mesh screen, and some of the particles being retained on each of a 20-, 28-, 35-, 48-, 100-, and 200-mesh screen. The powder consisting of various-size particles advantageously fills the voids between the prills more completely and with a higher resultant density than a powder consisting of uniformly sized particles. The pulverizing may be accomplished in a conventional hammer mill.

By way of example, 300 lbs. of coated ammonium-nitrate prills may be placed in a horizontal mixing machine and there sprayed with 18 lbs. of No. 2 fuel oil. Introduced on top of the coated prills and oil already in

the mixer is 400 lbs. of the powdered relatively dense ammonium nitrate. Subsequently an additional 300 lbs. of coated ammonium-nitrate prills are placed on top of the 400 lbs. of powder, to sandwich the latter between lower and upper layers of prills. Then an additional 42 lbs. of No. 2 fuel oil is sprayed over all of the material and the mixer is operated until the ingredients are all thoroughly mixed.

It is preferred to spray the fuel oil on the prills rather than on the powder to insure that the prills receive their proper proportion of the fuel oil. Otherwise, the high adsorption of the powder would deprive the prills of the portion of the fuel oil necessary thereto.

After thorough mixing, the mixture is bagged in any desired quantities. By way of example, the mixture may be passed to a bagging hopper and there fed in 50-lb. quantities, or other desired quantities, into appropriately sized waterproof bags, a 50-lb. bag being of the order of 7 inches in diameter and about 31 inches long. After the bags are filled with the mixture, they are vibrated to settle the mixture in the bags. The vibrator may be a standard platform vibrator with a pipe mounted on the platform of a size slightly larger than the bag diameter and slightly shorter than the length of the bag. With the filled bag inserted in the pipe, the latter transmits vibration throughout its entire length to the cartridge causing the mixture to assume its maximum density. The bag is then closed by any suitable means, such as a wire tie at the top of the bag.

The resultant mixture is of a density greater than 1, approximately equal to 1.1, to insure its sinking into a water-filled blasthole with the contents of the waterproof bag remaining dry. This eliminates the disadvantages of prior-art expedients, such as the use of highly compressed ammonium nitrate which is difficult to detonate, and also the use of metal or concrete in a cartridge or bag which occupies space otherwise available for explosive or blasting agent.

Rather, by the instant method and resulting mixture, the entire space occupied is available to the blasting agent, and the latter is quite simply detonated, a single primer serving to detonate several cartridges even in water-filled blastholes.

Moreover, the mixture of the instant invention has a detonation velocity of 14,000 feet per second, and its brisance value or power is even more markedly increased, the brisance power varying as the square of the detonation velocity. Hence, the instant mixture is between 60% and 75% more powerful than any prior mixtures utilizing only fertilizer-grade ammonium nitrate and oil.

Notwithstanding the considerably increased detonation velocity of the instant mixture, the mixture is non-cap-sensitive and classified as a blasting agent under the Code of the U.S. Bureau of Mines, so as to enjoy the safety and economic advantages thereof.

By way of ranges and variations in proportions, the advantages of the present invention are obtainable with good blasting efficiency in varying the ratio by weight of coated prills to relatively dense powder between 35:65 and 70:30. However, it is preferred that the ratio of coated prills to powder be between 60:40 and 50:50. In all cases, it is preferable to employ an oil content by

weight approximately 6% of the total mixture, permissible variation being between 3% and 9% by weight.

From the foregoing it is seen that the present invention provides a method of manufacturing a blasting agent, and the resultant mixture, which for the first time using only fertilizer-grade ammonium nitrate produces a mixture of density greater than 1.0, is free-running and resists caking for long periods of storage, possesses a detonation velocity of at least 14,000 feet per second without being cap sensitive, and which otherwise fully accomplishes its intended objects and is well adapted to meet practical conditions of manufacture, distribution, and use.

Although the present invention has been described in some detail by way of illustration and example for purposes of clarity of understanding, it is understood that certain changes and modifications may be made within the spirit of the invention and scope of the appended claims.

What is claimed is:

1. In a non-cap-sensitive blasting agent, the combination consisting essentially of a homogeneous mixture of relatively porous-coated fertilizer-grade ammonium-nitrate prills of a size to substantially completely pass through an 8-mesh screen and be retained on a 20-mesh screen, relatively dense crystalline powdered fertilizer-grade ammonium nitrate of particle-size distribution to substantially completely pass through a 20-mesh screen and be at least partially retained on screens of 28, 35, 48, 100 and 200 mesh, the ratio by weight of prills to powder being between 28:72 and 70:30, and fuel oil, the amount of oil being between 4% and 7% by weight of the total mixture, to define a free-flowing mixture having a density of at least 1.1 and a rate of detonation not less than 14,000 feet per second.
2. A blasting agent according to claim 1, said fuel oil being No. 2 fuel oil and uniformly distributed throughout the mixture.
3. A blasting agent according to claim 1, said porous-coated prills being of an approximate bulk density between .7 and .9, and said powder being ground from crystalline prills having a bulk density of between .9 and 1.1.

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