United States Patent Office 3,090,713 Patented May 21, 1963

3,090,713

COMPOSITION OF MATTER IN THE NATURE OF AN EXPLOSIVE

Frank Harold Fenix, Joplin, Mo., assignor of fifty percent to Glenn Cook, Arkansas City, Kans.

No Drawing. Filed June 19, 1958, Ser. No. 743,014
1 Claim. (Cl. 149—39)

This invention relates to a composition of matter in the nature of an explosive and more particularly, to an inexpensive and extremely powerful explosive composition using ammonium nitrate as the principal power producing agent.

Ammonium nitrate has heretofore been used in explosive compositions and in conjunction with a sensitizing agent such as the organic nitro compounds including trinitrotoluene, nitroglycerine and dynamite gels, but these prior ammonium nitrate explosives are subject to the inherent defect of being hygroscopic and thus, the compositions deteriorate during storage and use upon contact with moisture and water. In direct contact with water, these prior explosive materials often absorbed sufficient water either to show poor strength characteristics or became progressively inert to detonation. Thus, additional hazards and expense in blasting operations were caused by the utilization of ammonium nitrate and many operators refused to utilize such compositions, even though the same were much less expensive, because of the serious disadvantages referred to above. This was particularly true when the blasting composition was used in wet bore holes often encountered in actual field conditions, and for these reasons the widespread adoption of ammonium nitrate explosives has been precluded.

Attempts to produce a commercially practical ammonium nitrate explosive have continued, however, because of the relatively low cost of the same and the fact that ammonium nitrate explosives are classified as safe for most uses and are capable of being transported over long distances under all types of weather conditions. Extremely dangerous nitro compounds such as nitroglycerine have been almost universally used to sensitize ammonium nitrate but an explosive produced from an admixture of ammonium nitrate and nitroglycerine is not a permissible explosive composition under many shipping regulations, and these materials are dangerous to handle and use not only because of the erratic manner in which they explode, but also because of the fact that the conditions of the ambient atmosphere affect the power of the material as well as the degree of detonation thereof.

Various materials have been suggested as substitutes for trinitrotoluene, nitroglycerine and gel dynamite sensitizing agents but these materials have not been satisfactory for the most part because they have been incapable of properly detonating all of the ammonium nitrate, as well as not being able to propagate the explosion. Furthermore, the sensitizing agents are relatively expensive, thereby materially increasing the overall cost of the explosive as well as the precautions necessary in handling, transporting and using the same because of the dangerous nitro compounds employed in the admixture.

In this connection it is to be noted that it is desirable the explosive composition be capable of being detonated with a #6 blasting cap and yet absolutely safe for use in all types of mines and in particular, coal mines. Fertilizer grade ammonium nitrate prills are among the least expensive types of this material because of the economies effected in manufacturing of the same, but prior attempts to detonate ammonium nitrate prills have been completely negative in the absence of utilization of excessive quantities of highly dangerous sensitizing agents such as nitroglycerine. Manifestly, incorporation of sensitive nitro compounds into the ammonium nitrate operates to nullify the inherent advantageous characteristics of the material as outlined above and thus preventing widespread acceptance of explosives of this type.

It is, therefore, the most important object of this invention to provide a permissible explosive embodying ammonium nitrate as the principal power producing agent therein and including unique sensitizing materials, rendering the explosive capable of being detonated with a #6 blasting cap without the utilization of highly dangerous and expensive organic nitro compounds such as nitroglycerine.

Also an important object of the instant invention is to provide an explosive which is extremely inexpensive as compared with most commercial explosive compositions, because of the fact that fertilizer grade ammonium nitrate prills may be utilized as the principal explosive ingredient.

Another important object of this invention is to provide an explosive embodying as the principal component thereof, ammonium nitrate prills, wherein the sensitizing agent is a combination consisting of powdered aluminum and ferric oxide in predetermined relative proportions to effect ready detonation of the explosive and subsequent propagation of the explosion.

Also an important object of this invention is to provide an ammonium nitrate explosive which is safe enough to be used underground in all types of mining operations involving both coal and all types of minerals.

A further aim of the instant invention is to provide an ammonium nitrate explosive having unique sensitizing materials incorporated therewith and which explosive is uniform in performance, regardless of ambient weather conditions, and which retains its strength over extended periods of storage, regardless of the relative humidity of the area in which such explosive is stored.

Also an important aim of the invention is to provide an explosive of the type described which requires no tamping when placed in cartridges or the like, nor is any heating or processing of the materials necessary during manufacture of the explosive which would thereby increase the danger involved in production of the composition, as well as subsequent use thereof.

Other important objects of this invention relate to the provision of a permissible explosive utilizing ammonium nitrate as the principal ingredient thereof which does not have obnoxious gas and has a minimum of carbon monoxide resulting from an explosion thereof, so that the material may be used under any blasting conditions encountered, whether aboveground or underground; to an explosive wherein the velocity of the explosion may be controlled by varying the relative particle size of certain components of the explosive admixture; to the provision of an explosive wherein the ammonium nitrate has a certain proportion of crushed particles in combination with the prills which thereby operates to increase the effectiveness of the final composition; to an ammonium nitrate explosive having an outer coating thereon substantially precluding passage of moisture to each individual prill; to the provision of a free-flowing explosive which permits the same to be readily poured into a blast hole regardless of the degree of moisture present, the composition exploding with much higher velocity and in substantially complete safety because of the freedom from hazard of ignition by a spark or the like; to the provision of an explosive having carbonaceous material and abrasive substances in the same to assure uniform propaga-

tion of the explosion; to an explosive which may be readily varied to change the velocity of the same as desired by merely adding suitable, inexpensive components to the final admixture; and to other important objects and salient features of the instant invention which will become obvious or be explained more fully as the following specification progresses.

Briefly, the instant explosive composition includes predetermined portions of ammonium nitrate prills, extra finely divided atomized aluminum powder, ferric oxide, powdered lime dust and ground white glass with a combination of nitrobenzene, toluene and glycerine being utilized as a propagation and binding agent.

Describing in detail the various components of the instant explosive, as well as additional additives which may be employed to improve the final product for certain specific applications, it is to be noted that the ammonium nitrate utilized as the principal power producing agent is of the type commercially prepared by various manufacturers, principally in Midwestern areas, chiefly for fertilizer purposes. The molten ammonium nitrate during production thereof is permitted to drop from a considerable height within a tower so that small spheres are thereby produced which cool during gravitation through the tower and, upon reaching the bottom thereof, are collected in suitable means for passage to packaging areas. The spherical particles thereby formed and which are generally termed "prills" vary somewhat in size but a representative sample had an average individual mean diameter of 0.075 in. 100% of the sample passed through a #6 screen, 56.3% went through a #10 screen, 20.7% passed through a #12 screen, 12.4% went through a #14 screen, 8.5% passed through a #20 screen while only 2.8% went through a #35 screen. This ammonium nitrate product is commercially available in 97% pure form with only approximately 3% consisting of inert ingredients. The chemically pure grade of ammonium nitrate comprising 99% of the pure compound may be employed if desired, but the standard commercial grade is much less expensive and gives satisfactory results under all operating conditions encountered.

The ammonium nitrate prills utilized in preparation of the instant explosive are of the uncoated variety, and approximately 90% of the total material is in the form of small spheres, as defined above, while about 10% of the material is in fragmented form which is hereinafter referred to as being "crushed" by virtue of the manner in which the same is produced, namely, falling through an extended path of travel from the top of the tower to the lower end thereof where the prills are collected. The small proportion of fragmented or broken prills have been found to be of advantage in formulation of explosives as contemplated by this invention because of the way in which such fragmented proportion of the ammonium nitrate improves the overall power of the composition, as well as the uniformity of detonation thereof, irrespective of the time which the product is stored prior to use of the same.

The ammonium nitrate prills described above are relatively insensitive to detonation and therefore, it is necessary to employ certain specific sensitizing agents in conjunction with such prills in order to permit the same to be detonated with a #6 blasting cap or equivalent means. An admixture of properly ground, atomized aluminum in conjunction with predetermined proportional amounts of ferric oxide has been found suitable for sensitizing the ammonium nitrate prills and also serves to propagate the explosion once the same has commenced. In this connection it is to be noted that atomized aluminum ground to an extremely fine mesh size, substantially finer than #120 aluminum powder, gives best results and by the same token, the ferric oxide should be highly comminuted in order to assure uniform distribution of the same throughout the explosive composition. Empirical tests have indicated that the ratio of atomized aluminum to ferric oxide should be maintained approximately at 1 part of aluminum for each 3 parts of ferric oxide by weight of the total admixture.

The basic formulation set forth above may be modified for certain specific uses by incorporation of a carbonaceous material into the admixture to thereby assure uniform propagation of the explosion. The preferred composition includes activated charcoal therein because this material is capable of absorbing many times its weight of poisonous gases, thereby making the instant explosive compositions safe for utilization in enclosed areas such as coal mines and the like, and furthermore, the activated charcoal provides the proper amount of carbon to enhance detonation and propagation of the explosion even though relatively large ammonium nitrate prills are utilized as the main power producing material of the admixture. In certain applications though, it is desirable to utilize high velocity powdered coal in lieu of the activated charcoal and in this formulation, preselected quantities of sulfur should also be added in order to assure proper detonation and complete explosion of all of the ammonium nitrate prills.

High velocity coal as used herein is intended to designate coal having a relatively high methane content. For use in explosives, this coal is ground to a very fine form and then intimately admixed with the other materials.

It is also necessary that a finely divided abrasive be added to the explosive composition and although many materials meeting the hereinafter referred to specifications could be employed, it has been determined that the best results are obtained by utilization of finely divided ground glass and/or calcium oxide, generally termed lime dust. The ground glass, which is preferably of the white variety, operates not only as a drying agent to prevent the ammonium nitrate from absorbing considerable quantities of water, but also aids in triggering of the explosion of each of the ammonium nitrate prills because of the gritty nature of the glass. By the same token, the calcium oxide operates in a similar manner to facilitate complete detonation of the entire quantity of ammonium nitrate prills and smooths out the detonation so that maximum power is obtained from each particular formulation.

In many instances, it is desirable to incorporate a preselected proportion of sodium nitrate in the explosive admixture to vary the velocity of the resulting explosion and change the power of the same as compared with standard dynamite. The manner in which sodium nitrate produces reduction in power of the instant explosive admixture is not understood, but tests have shown that the greater the proportion of sodium nitrate, the less powerful the instant composition, as compared with dynamite.

In order to improve the explosive power of the present composition and also to provide a substantially moisture resistant coating around each individual prill of ammonium nitrate, it is recommended that an admixture of toluene, nitrobenzene and glycerine be introduced into certain of the components of the present explosive during manufacture of the same to thereby cause a relatively moisture impervious layer to be formed over each individual ammonium nitrate prill. In this connection, it has been shown that approximately one pint of the liquid should be added to each 100 pounds of the final admixture, and further, that the toluene, nitrobenzene and glycerine should be present in approximately equal amounts.

Another component which has been found to improve the overall results of the present explosive, particularly when a relatively low power admixture is desired, is sugar roasted to a light brown color and incorporated into the composition in predetermined proportions.

To more clearly define the various components which may be utilized in the instant explosive, as well as the most suitable proportions thereof to obtain improved results, it is pointed out that the following ingredients

may be admixed with the quantities of each being expressed as by parts by weight:

Ammonium nitrate	60 to 98.
Extra fine, atomized aluminum	0.5 to 2.
Ferric oxide	1.5 to 6.
Finely divided ground glass, approximately	0.5.
Powdered lime dust, approximately	0.5.
Toluene-nitrobenzene-glycerine (toluene, nitrobenzene and glycerine should be in approximately equal amounts)	1 pint for each 100 parts by weight of the total admixture.

In certain applications it is desirable to add a carbonaceous compound which may be about 3 parts activated charcoal or approximately 2.5 parts of finely ground, high velocity coal and 3 parts of sulfur.

Specific examples of explosive compositions include the following:

Example 1

	Parts by wt.
Ammonium nitrate (approximately 90 11-mesh prills with the remaining percentage being in crushed form)	93
Extra fine powdered, atomized aluminum	1.5
Ferric oxide	4.5
Powdered lime dust	0.5
Finely divided ground glass (white)	0.5
Nitrobenzene-glycerine-toluene in equal parts sufficient to provide 1 pint of the liquid for each 100 parts by weight of the total admixture.	

This admixture is equivalent to 90% dynamite.

Example 2

	Parts by wt.
Ammonium nitrate (approximately 90% 11-mesh prills with the remaining percentage being in crushed form)	60
Sodium nitrate	28.5
Extra fine powdered, atomized aluminum	1
Ferric oxide	3
Activated charcoal	3
Lightly roasted sugar (light brown color)	2.5
Finely divided ground glass (white)	0.5
Powdered lime dust	0.5
Nitrobenzene-glycerine-toluene in equal parts sufficient to provide 1 pint of liquid for each 100 parts by weight of the total admixture.	

The above explosive composition is equivalent to 40% dynamite.

Example 3

	Parts by wt.
Ammonium nitrate (approximately 90% 11-mesh prills with the remaining percentage being in crushed form)	60
Sodium nitrate	28.5
Extra fine powdered, atomized aluminum	1
Ferric oxide	3
Sulfur	3
Lightly roasted sugar (light brown color)	2.5
Powdered high velocity coal	2.5
Finely divided ground glass (white)	0.5
Powdered lime dust	0.5
Nitrobenzene-glycerine-toluene in equal parts sufficient to provide 1 pint of liquid for each 100 parts by weight of the total admixture.	

This composition is also equivalent to 40% dynamite.

Example 4

	Parts by wt.
Ammonium nitrate (approximately 90% 11-mesh prills with the remaining percentage being in crushed form)	91
Extra fine powdered, atomized aluminum	2
Ferric oxide	6
Finely divided ground glass (white)	0.5
Powdered lime dust	0.5
Nitrobenzene-glycerine-toluene in equal parts sufficient to provide 1 pint of liquid for each 100 parts by weight of the total admixture.	

This explosive composition is equivalent to 100% dynamite.

Example 5

	Parts by wt.
Ammonium nitrate (approximately 90% 11-mesh prills with the remaining percentage being in crushed form)	84
Sodium nitrate	6
Extra fine powdered, atomized aluminum	1
Ferric oxide	3
Sulfur	3
Powdered high velocity coal	2.5
Finely divided ground glass (white)	0.5
Powdered lime dust	0.5
Nitrobenzene-glycerine-toluene in equal parts sufficient to provide 1 pint of liquid for each 100 parts by weight of the total admixture.	

This formulation is equivalent to 60% dynamite.

In production of the instant explosive it is essential that the ammonium nitrate prills be subjected to sufficient warm air during manufacture of the composition to substantially remove all of the moisture from the prills prior to coating of the same with the sensitizing and detonation promoting agent, as set forth in the examples above. Removal of the water from the ammonium nitrate prills may be accomplished in various ways, but it is noted that a convenient and inexpensive process involves disposing the prills on a conveyor belt and then passing the same through cross or countercurrent air flow at an elevated temperature. After the ammonium nitrate prills have been thus subjected to moisture-removing currents of air, the aluminum sensitizing agents are admixed with the ammonium nitrate prills, whereupon the abrasive and propagation promoting materials are introduced into the mixing machine. If carbonaceous materials such as activated charcoal or high velocity coal are to be utilized in the particular formulation, these are then directed into the mixer in conjunction with the sugar and sulfur if the same are used. Finally, after intimate admixing of the above listed dry ingredients, the liquid containing nitrobenzene, glycerine and toluene is directed into the mixer which tends to cause the various detonation initiation and propagation promoting materials to uniformly coat the ammonium nitrate prills to thereby form a moisture resistant layer over the outermost surface of each prill. It can be recognized that the hygroscopic nature of the ammonium nitrate prills facilitates placement of the coating over the outer surfaces of the same because of the slight amount of water which is absorbed after the prills have been subjected to warm currents of air, and the layer thereby formed over the prills permits the present composition to be stored over extended periods of time without the same becoming hard or setting up.

The mixing time of the various ingredients should be maintained as low as practical to assure complete dispersion, but such time should preferably be within the range of two to three minutes. The final product is in condition for immediate packaging and may be placed in cardboard, cylindrical cartridges previously coated on the inner surface thereof with a toluene-nitrobenzene admixture and provided with a paraffin coating on the outer surface thereof to preclude entrance of moisture into the

cartridge. Opposed ends of each of the cylinders are capped with metal covers, whereupon the cartridge is in condition for immediate detonation with a #6 blasting cap or equivalent means. Note should be taken particularly of the fact that the present composition is not packed or tamped into the cartridge but merely permitted to flow into the same. No packing or tamping is required and thus, manufacture of the product is not only made much safer but a uniform explosion is obtained because of the substantially simultaneous detonation of each of the ammonium nitrate prills contained therein.

Under certain blasting specifications, it is oftentimes advantageous to incorporate a synthetically produced composition, including lime dust and silica, into the explosive. A product of this type is commercially available and is substantially fluffy in appearance and relatively lightweight. The detonation and propagation of the explosion of ammonium nitrate when this material is introduced into the explosive admixture has been found to be more uniform and complete.

Although it has heretofore been stated that one of the principal features of the instant explosive composition is the fact that the same may be detonated with a #6 blasting cap, it is also to be understood that other detonation means may be employed with equal facility and advantage. For example, "Primacord" may be utilized in each of the cartridges to thereby effect the necessary detonation. "Primacord" is formed of an admixture of lead styphnate, trinitrotoluene and lead azide within an elongated, flexible tube of plastic material and which may be disposed in each cartridge extending longitudinally thereof.

Since the explosive compositions defined herein are relatively free-flowing materials, it can be appreciated that the same are particularly adapted for utilization in underground mining and quarrying operations and may be used in coal mines because of the inherent safety of the explosive. Not only is the composition classified as a permissible explosive, but the same may be utilized in blast holes drilled in the surface to be blasted without the necessity of utilization of a cartridge type blasting material. Furthermore, moisture does not detrimentally affect the explosive under most conditions, and the product is useable under varying conditions.

Not only is the explosive relatively inexpensive because of the specific materials utilized therein, but the explosive power of the composition may be varied as desired by simple expediments involving either addition of suitable quantities of sodium nitrate to the material or by changing the degree of fineness of the carbonaceous materials introduced into the admixture. It is to be understood that the finer the grind of the carbonaceous material, the more abrasive the explosion.

Although certain specific materials have been set forth herein, it is to be understood that all chemical equivalents are contemplated and it is desired that the invention be limited only by the scope of the appended claim.

Having thus described the invention what is claimed as new and desired to be secured by Letters Patent is:

An explosive consisting essentially of by weight of the total admixture, 60 to 98 parts of fertilizer grade, prilled, uncoated ammonium nitrate, 0.5 to 2 parts of powdered aluminum, 1.5 to 6 parts of ferric oxide, approximately 0.5 part of ground glass, about 0.5 part of calcium oxide, and one pint for each 100 pounds of said admixture of equal proportions of nitrobenzene, glycerine and toluene.

References Cited in the file of this patent

UNITED STATES PATENTS

2,126,401	Lindsley	Aug. 9, 1938
2,407,151	Glogau	Sept. 3, 1946
2,410,801	Audrieth	Nov. 12, 1946
2,436,305	Johnson	Feb. 17, 1948
2,478,918	Hale et al.	Aug. 16, 1949

FOREIGN PATENTS

677,722	France	Dec. 18, 1929
479,261	Canada	Dec. 11, 1951