July 13, 1943. W. M. COBB, JR 2,324,363

AMMONIUM NITRATE EXPLOSIVE

Filed April 11, 1939 2 Sheets-Sheet 1

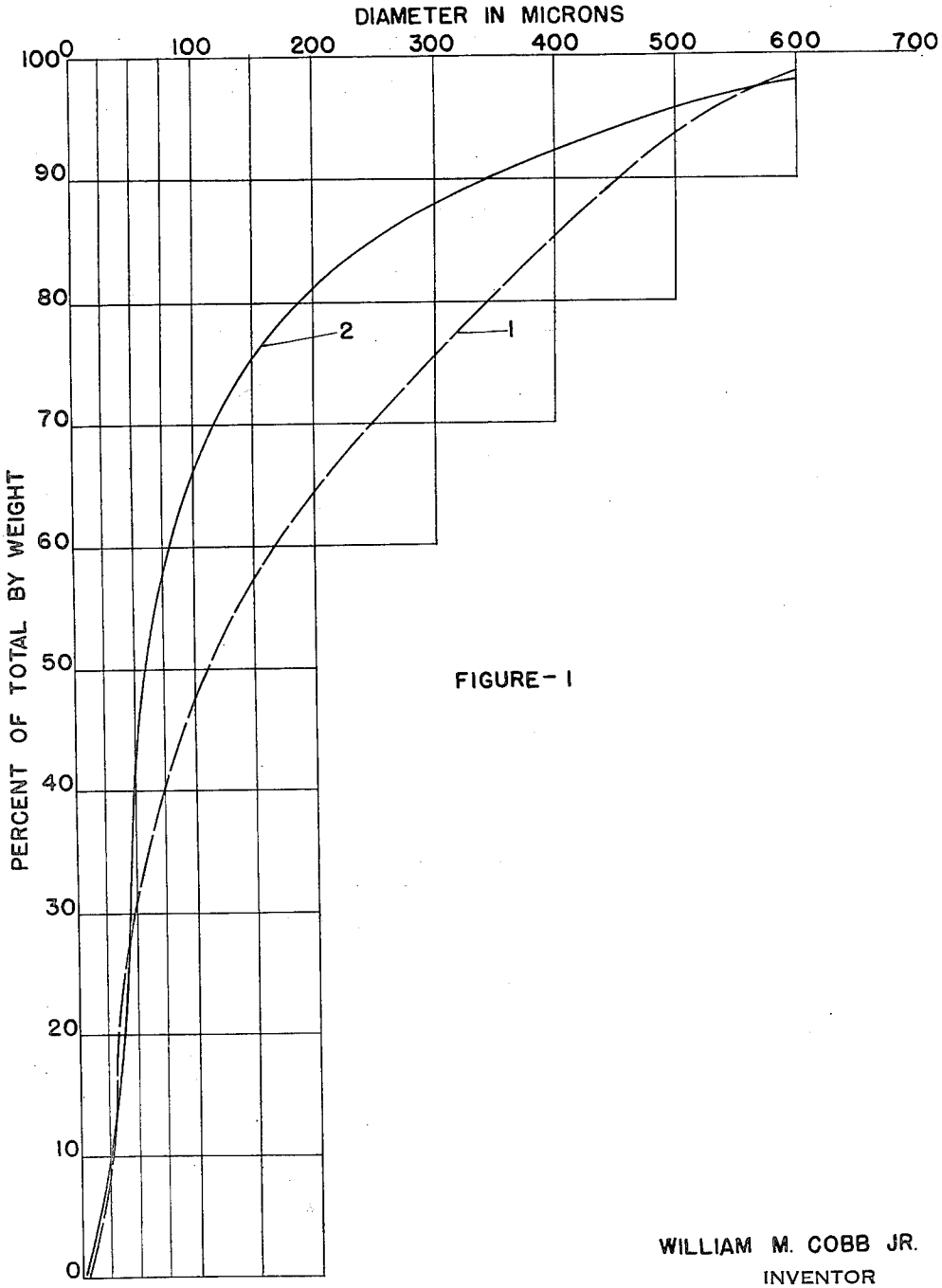


FIGURE - 1

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AMMONIUM NITRATE EXPLOSIVE

Filed April 11, 1939 2 Sheets-Sheet 2

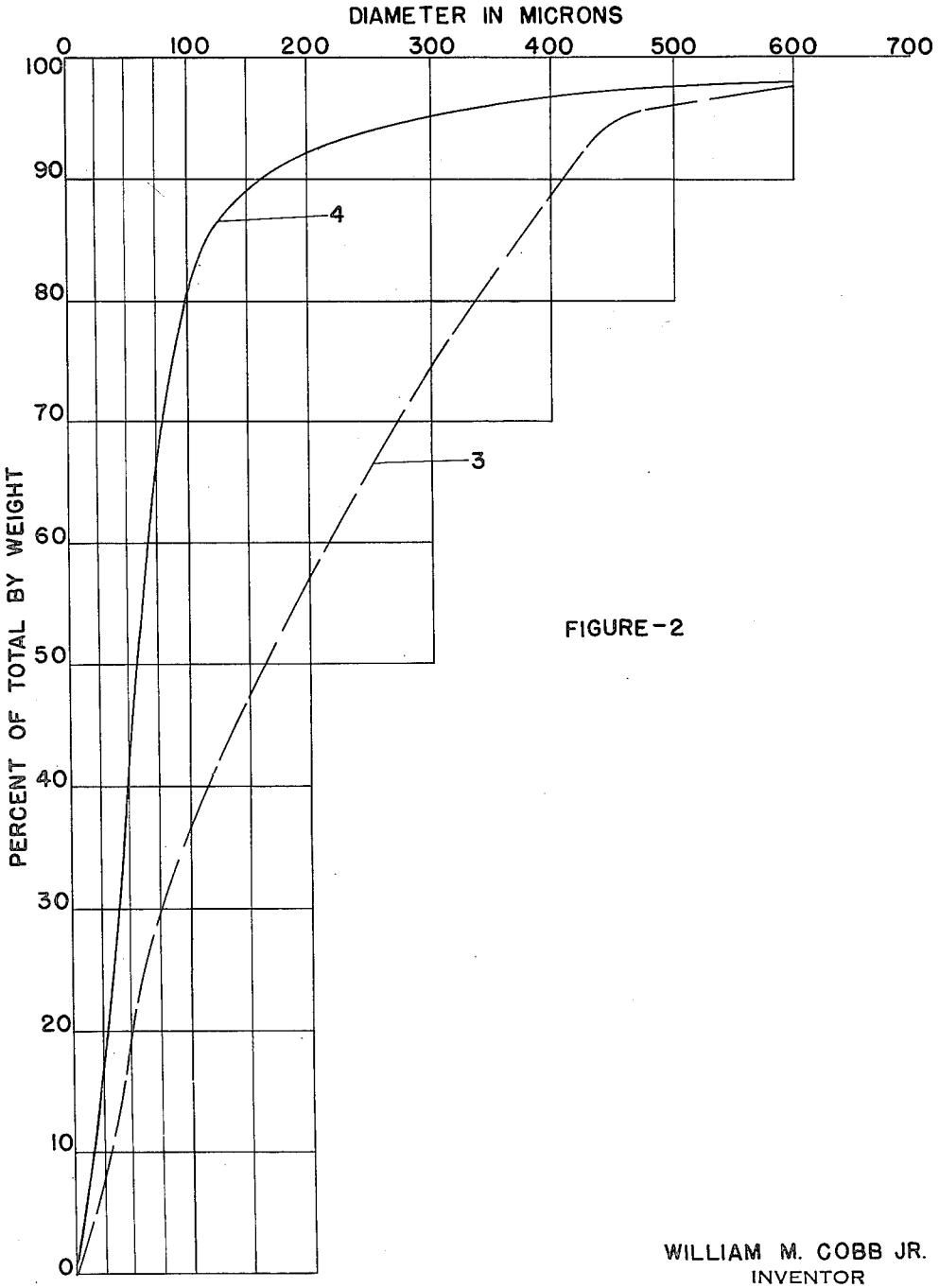


FIGURE-2

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Patented July 13, 1943 2,324,363

UNITED STATES PATENT OFFICE

2,324,363

AMMONIUM NITRATE EXPLOSIVE

William M. Cobb, Jr., Wilmington, Del., assignor to Hercules Powder Company, Wilmington, Del., a corporation of Delaware

Application April 11, 1939, Serial No. 267,324

18 Claims. (Cl. 52—11)

This invention relates to an improvement in blasting explosives and more particularly to an explosive of improved sensitiveness, said explosive being of the ammonium nitrate safety type and containing no nitroglycerin or similar sensitizing agent.

Ammonium nitrate explosives have been divided by the art into two general classes:

1. Relatively insensitive or safety explosives, and

2. Sensitive explosives, i. e. explosives containing nitroglycerin or a similar sensitizing agent. Both classes of these ammonium nitrate explosives must contain one or more sensitizers since ammonium nitrate alone, while capable of detonation by a very high initial shock or impulse, is too insensitive for detonation by commercial blasting caps and further would not, if detonated, propagate itself throughout the explosive column in a bore hole.

The ammonium nitrate safety dynamites have used a variety of sensitizing agents, principally of the carbonaceous type, but such materials as salts, oxides, peroxides, and a few elements have also been used to some extent. While the preparation of these explosives by mechanical admixture, by coating, and by fusion has produced safety dynamites which may be used in industry each of the compositions have been of such low sensitiveness that a booster charge or a high power blasting cap is necessary to cause complete detonation. Extreme care must, therefore, be taken when loading these safety dynamites into bore holes that no gaps are left in the column as the explosive is not sufficiently sensitive to jump even a short gap.

The object of this invention is the production of a safety type explosive from ammonium nitrate and a carbonaceous sensitizing material that will be sufficiently sensitive to insure positive detonation with a commercial blasting cap. A further object of this invention is the production of a safety type explosive of two or more components by incorporating ammonium nitrate and one or more carbonaceous materials in a ball mill. Other objects will appear hereinafter.

Now in accordance with this invention I have prepared a new and improved safety explosive comprising an intimate admixture of particles of ammonium nitrate and particles of one or more carbonaceous sensitizing materials, such as for example rosin, coal, sugar, gasoline insoluble resins derived from pine wood or the like. The explosive of this invention may be prepared to have any desired sensitiveness by controlling the particle size of the individual ingredients in the admixture. Thus, in accordance with this invention the ingredients of my new explosive are reduced in particle size and intimately admixed to a degree that produces an explosive of the desired sensitiveness. The reduction of the particle size and the intimate admixing procedures may be conveniently carried out simultaneously in any suitable apparatus such as a ball mill. I have expressed the sensitiveness of the explosive in terms of the impulse needed to cause complete detonation.

To adequately illustrate the degree to which the sensitivity of an explosive prepared in accordance with this invention may be controlled by the reduction of the particle size two drawings are appended. The drawings, Figures I and II show the particle size distribution obtained for explosives of different sensitivities. Figure I illustrates graphically the particle size distribution obtained when a specific explosive, comprised of 94% by weight of ammonium nitrate and 6% by weight of a gasoline insoluble resin derived from pine wood, is prepared so that it will be detonated when primed (1) with a standard No. 10 blasting cap, or (2) with a standard No. 6 blasting cap. Thus, curve 1 of Figure I shows that it is necessary to have about 47% by weight of the particles less than 100 microns in diameter, about 31% by weight of the particles less than 50 microns in diameter and about 9% by weight of the particles less than 25 microns in diameter, if the explosive is to detonate under the impulse wave furnished by a #10 blasting cap. Further, it will be noted from curve 2 of Figure I that, in order to produce an explosive which will detonate with a #6 blasting cap, the particle size distribution is such that about 66% by weight of the particles are less than 100 microns in diameter, about 42% by weight of the particles are less than 50 microns in diameter, and about 9% by weight of the particles are less than 25 microns in diameter. Thus the smaller particle size gives the greater sensitivity.

Another specific example of the relation between the particle size of the explosive of this invention and the sensitiveness of this said explosive is illustrated in Figure II. The explosive illustrated in Figure II is comprised of 96% by weight of ammonium nitrate and 4% by weight of a soft coal, specifically this coal was a bituminous coal of low-volatile content. The particle size distribution necessary to cause this explosive to be detonated by the impulse wave of a #10 blasting cap is illustrated by curve 3 and shows

that the particle size distribution is about 37% by weight of the particles less than 100 microns in diameter, about 20% by weight of the particles less than 50 microns in diameter, about 8% by weight of the particles less than 25 microns in diameter. In order to obtain detonation of this explosive with a #6 blasting cap, the particle size distribution, as shown by curve 4 must be about 81% by weight of the particles less than 100 microns in diameter, about 42% by weight of the particles less than 50 microns in diameter, and about 16% by weight of the particles less than 25 microns in diameter.

The #6 and #10 caps used above were standard strength as indicated by the U. S. Bureau of Mines, that is, the #6 cap contains 1 gram and the #10 cap contains 3 grams of a 90–10 mercury fulminate-potassium chlorate mixture. The #6 cap is the strength usually used by the art, while a #10 cap is about the strongest which could be commercially obtained.

It will be obvious to those skilled in the art that to control the sensitiveness of every explosive batch by individual microscopic determinations of particle size distribution would require considerable time and expense, so I have classified the sensitiveness of the explosive compositions of this invention by reference to their ability to detonate with definite strength standard blasting caps. The curves of Figures I and II will serve to give a close indication as to the particle size distribution which may be expected to be necessary for any particular sensitivity desired in any specific explosive prepared in accordance with this invention, but limitation and sensitivities will be hereinafter referred to in relation to the various strength blasting caps.

The ammonium nitrate used in the production of the safety explosives prepared in accordance with this invention may be any of several types obtainable. Although I may use any of the substantially pure commercial grades of ammonium nitrate, I prefer to use ammonium nitrate of the type prepared for use in ammonium nitrate dynamites. Ammonium nitrate for use in ammonium nitrate dynamites may be, for example, substantially pure, grained or crystallized material to which may or may not have been added small quantities of substances to improve its water resistance. Such substances consisting of metal oxides, rosin, paraffin or the like are added only in very small percentage to the ammonium nitrate and do not in any way affect the properties of the safety explosive of this invention. Treated ammonium nitrate is more expensive than the normal substantially pure product and therefore, since results obtained are found to be equal, I prefer to use the less expensive material. Ammonium nitrate may be of varying size grains but when used in the production of the safety explosive of this invention, I prefer to use material of about ten mesh size for the charging of the mill, due to the convenience of handling. Ammonium nitrate after crystallization is dried and we find that the drier the ammonium nitrate used to charge the ball mill, the more efficiently the ball mill will grind and that trouble with caking of the ball mill charge will be lessened.

There are many carbonaceous materials which will act as sensitizers for ammonium nitrate, but I have found that only those compounds which are sufficiently brittle to be ground, at room temperature, to particles of very small diameter are suitable for use in my safety explosive. This requirement of brittleness is an inherent characteristic of many substances such as, for example, rosin, coal, sugar, gasoline insoluble resins derived from pine wood such as are described in U. S. Patent 2,102,122 and the like and I have found that these types of carbonaceous sensitizing material are suitable for use in my safety explosive. I prefer to use carbonaceous sensitizing materials which have a softening point above room temperature as the grinding procedure will normally be carried out at existing room temperatures, but I do not limit myself to such substances as the temperature of grinding may be maintained at any convenient point to effect efficient grinding.

In accordance with this invention the preparation of this safety explosive is preferably accomplished by incorporating in a ball mill ammonium nitrate and a compound such as sugar, rosin, coal, gasoline insoluble resin derived from pine wood or the like. The materials are ground by a ball mill to the fine state of sub-division necessary to impart a sensitiveness characterized by the fact that the finished product will when unconfined and at a density of 1.1 grams per cc., be detonated by a No. 6, U. S. Bureau of Mines blasting cap. I have found that it is desirable in this grinding procedure to use a ball mill of such size in relation to the charge of explosive to be ground, and to the size and mass of steel balls or other grinding aggregates that an efficient grinding action is obtained; further that the grinding procedure is to be carried out in a manner that will prevent the absorption of water by the explosive ingredients; further that upon loading the mill all ingredients and apparatus shall be thoroughly dry; further that during the grinding operation the temperature of the entire mill and contents shall be controlled and kept well below the softening point of the carbonaceous material being incorporated with the ammonium nitrate.

It is well known that ammonium nitrate will absorb water from the air under definite conditions of humidity and temperature. The critical conditions, of course, vary for different temperatures but such conditions may be illustrated by the following specific examples. At a temperature of 68° F. and a relative humidity of 65% or at 90° F. and 57% relative humidity the ammonium nitrate begins to absorb moisture from the air.

Now, because of this critical point the grinding operation in accordance with this invention has been carried out in an atmosphere having a relative humidity below the critical value affecting the ammonium nitrate. The grinding process when carried out at a humidity above the critical ranges causes the material in the ball mill to cake which necessitates either or both the additional steps of breaking down this cake and drying the product.

It is to be understood that other efficient methods, well known to the art, of incorporating the ammonium nitrate and carbonaceous material may be substituted for the ball mill method hereinbefore described.

The safety explosive in accordance with this invention is composed of ammonium nitrate within the range of about 90% to about 98%, preferably about 93% to about 95%, incorporated with one or more carbonaceous materials from the group comprising sugar, rosin, coal, and gasoline insoluble resin derived from pine wood, in the range of about 2% to about 10%, preferably about 5% to about 7%.

A specific example of an embodiment of this invention is the incorporation by ball mill grinding of 94% ammonium nitrate with 6% gasoline insoluble resin derived from pine wood. The details of the process as carried out are as follows:

A dry, clean ball mill is charged in a substantially dry atmosphere with 2,820 grams of ammonium nitrate and 180 grams of gasoline insoluble resin derived from pine wood, both materials having been reduced to less than ten mesh size particles before weighing the charges. Into the ball mill are placed 24 kilograms of steel balls, about 50 balls of about 2" diameter, the ball mill closed tightly and rotated on a rack so provided for a period of about seven hours. After this grinding procedure the material is removed from the ball mill and packed into the desired size cartridges. The removal of the explosive should be carried out in a substantially dry atmosphere. After packing the explosive in cartridges and dipping the cartridges in a water proofing compound such as paraffin the safety explosive is ready for storage and marketing.

While I have used a period of about seven hours for grinding the explosive of this invention, I may vary this grinding time over a wide range. The actual time of grinding must be determined by the following factors: the type of mill used; the size, kind, and amount of grinding aggregates; the charge of material; and the dryness of the materials. Further, the time of grinding affects the sensitiveness of the explosive since it controls the particle size. Therefore, the explosive of this invention must be ground until the desired sensitiveness is obtained.

The safety type ammonium nitrate explosive above described has been tested by various accepted dynamite tests for sensitiveness, water resistance, weight strength, impact resistance, friction sensitiveness, rate of detonation, and inflammability. The results of each of these tests have shown the safety explosive of this invention to be the equal of various particular commercial dynamites and to be a superior type safety explosive in regard to sensitiveness to detonation by a No. 6 U. S. Bureau of Mines blasting cap.

Although the safety explosive of this invention may be packed in any size cartridge, it will when used commercially normally be packed in large size cartridges, for example, 4" x 8" or 7½" x 24". To standardize the testing of this safety explosive, we have maintained a standard count of 150 1¼" x 8" cartridges per 50 pounds of explosive which corresponds to an explosive having a density of about 1.0 gram per cc. A decrease or increase in the standard count of 150 1¼" x 8" cartridges per 50 pounds, will quite naturally alter the test results slightly but this is true when testing any commercial dynamite, therefore an established count is essential in duplicating and comparing results. In the following tests made there was used a safety explosive consisting of a blend of several lots of the explosive made in accordance with the specific example hereinbefore described and packed to the standard count described above.

1. Sensitiveness test results using a No. 6 E. B. cap:

Regular and modified sensitiveness at least 1 inch.

The above result for regular sensitiveness was obtained by "explosion by influence," or "halved-cartridge gap method," in which two half sticks are rolled together in manila paper with the two cut ends facing each other and a definite distance apart. The regular sensitiveness is defined as the maximum distance at which detonation of the second half cartridge is effected by the explosion of the first. The modified sensitiveness is defined as the maximum distance at which detonation of the second half cartridge is effected by the explosion of the first, when the half cartridges are so placed that their crimped ends face each other, the detonator being placed in that half cartridge which contains the upper, or packing machine crimp.

2. Water resistance: The water resistance test used consists of packing the powder in a 25 cc., Gooch crucible, tying a piece of cheesecloth over the top and hanging the same under 2" of water at 65° F. to 70° F. for a definite time. After this exposure the wet powder is scraped off and the weight of the remainder used in calculating the percentage good.

47%—good after 4 hours immersion.
0%—good after 8 hours immersion.

3. Weight strength in ballistic mortar=63.0%.

4. Impact resistance: Firmly packed powder not detonated by service rifle bullet at 100 yards.

5. Friction pendulum test: No evidence of detonation in five tests with steel shoe against steel anvil.

6. Rate of detonation: Between 4000 and 4300 M. P. S. (13,100 to 14,100 F. P. S.).

7. Inflammability: Fails to ignite on contact with open flame.

A general comparison of the test results obtained with my safety explosive with other types of explosives on the market indicates that,

1. The modified sensitiveness equals that of low rate permissibles.

2. The rate of detonation is equal to that of 35% L. F. N. G. dynamites.

3. The water resistance is equal to or better than that of ammonium nitrate dynamites, made with coated ammonium nitrate.

4. Impact and friction pendulum test results equal those obtained with other safety explosives.

5. The safety explosive of this invention is less readily ignited in inflammability tests than any dynamite or black powder.

The safety explosive of this invention will normally for commercial use, as stated hereinbefore, be packed in large size cartridges for use in open explosive operations, and therefore the combined oxygen balance, that is, the oxygen balance of the explosive including its wrapper, is not of great importance; but in the case of packing this safety explosive in small size cartridges, the combined oxygen balance will decrease to an extent that is not desirable. Explosives deficient in oxygen are undesirable because they are known to produce dangerous quantities or carbon monoxide upon detonation. I, therefore, contemplate the adjusting of the oxygen balance of the explosive in accordance with this invention by the addition of a suitable material to the mixture.

Now I have found that by the addition of small amounts of a metal nitrate, for example, sodium or potassium nitrate, to my explosive, I may so adjust the oxygen balance of this safety explosive when packing it in small cartridges that the finished cartridges are comparable to permissible dynamites with respect to oxygen balance. This favorable comparison allows the production of a safety type ammonium nitrate explosive that may be used in explosive operations in which the fumes produced must be controlled.

To adequately control the oxygen balance of

my safety explosive, I may blend up to about 6% of a metal nitrate with the safety explosive, the percentage of metal nitrate to be added being determined by the combined oxygen balance desired of the particular size cartridge being packed. The explosive properties of the safety explosive to which has been added a metal nitrate are not altered to any substantial degree.

Further, the safety explosive prepared in accordance with this invention when packed in small, for example, 1¼" x 8" cartridges has a high cartridge count and consequently a low cartridge strength. The normal count obtained when packing this explosive in 1¼" x 8" shells is about 145 to about 155 cartridges per 50 pounds and this cartridge count gives a cartridge strength of about 25%, but it is sometimes desirable to pack this type explosive to a lower cartridge count and therefore obtain an explosive of higher cartridge strength. Now I have found that the cartridge count of my safety explosive may be lowered to about 125 with the consequent raising of cartridge strength to about 37% by the process of blending the prepared material which gives a 150 count with about an equal weight of ammonium nitrate having a screen size within the range of about 10 mesh to about 60 mesh. The properties of this blended material are different from the properties of my safety explosive of 150 count in that the sensitiveness and rate of detonation are both slightly lower. Further it will be appreciated by those skilled in the art that by varying the percentage of ammonium nitrate blended with my safety explosive, I may obtain a very useful explosive having a 1¼" x 8" cartridge count between about 125 to about 155 per 50 pounds.

The explosive of this invention is primarily for commercial use but I have found that it is also suitable for use in high explosive military projectiles, such as, shells, torpedos, or bombs. The use of this explosive in military projectiles gives comparable results to the TNT now used when my explosive is packed into the projectile at a density of about 1.4 to 1.6 grams for cc.

Now in addition to possessing excellent explosive and safety properties my safety explosive is advantageous to manufacture and use due to the absence of any nitro compound, chlorate, or finely divided metals, which classifies this explosive as non-headache producing, non-leaking, non-freezing, non-inflammable, and insensitive to impact, but still of sufficient sensitiveness to insure detonation when primed with a U. S. Bureau of Mines blasting cap. Further, the character of this safety explosive provides an explosive for use in well-drilled holes that is safe to load, economical to use, and of a high strength.

It will be understood that the details and examples given hereinbefore are illustrative only, and in no way limiting on my invention as broadly described hereinbefore and in the appended claims.

What I claim and desire to protect by Letters Patent is:

1. A cap sensitive ammonium nitrate blasting explosive of the safety type including as the principal explosive ingredient an intimate admixture comprising essentially ammonium nitrate and a non-explosive carbonaceous sensitizer, the said intimate admixture comprised of particles a major portion of which have a diameter less than 200 microns and characterized by a sensitiveness such that, when unconfined and at a density greater than 1.1 gm./cc., it may be detonated with a No. 10 blasting cap.

2. A cap sensitive ammonium nitrate blasting explosive of the safety type including as the principal explosive ingredient an intimate admixture comprising essentially ammonium nitrate and a non-explosive carbonaceous sensitizer, the said intimate admixture comprised of particles a major portion of which have a diameter less than 100 microns and characterized by a sensitiveness such that, when unconfined and at a density greater than 1.1 gm./cc., it may be detonated by a No. 6 blasting cap.

3. A cap sensitive ammonium nitrate blasting explosive of the safety type including as the principal explosive ingredient an intimate admixture comprising essentially ammonium nitrate and a substantially petroleum hydrocarbon insoluble resin, the said intimate admixture comprised of particles a major portion of which have a diameter less than 200 microns and characterized by a sensitiveness such that, when unconfined and at a density greater than 1.1 gm./cc., it may be detonated with a No. 10 blasting cap.

4. A cap sensitive ammonium nitrate blasting explosive of the safety type including as the principal explosive ingredient an intimate admixture comprising essentially ammonium nitrate and a substantially petroleum hydrocarbon insoluble resin, the said intimate admixture comprised of particles a major portion of which have a diameter less than 100 microns and characterized by a sensitiveness such that, when unconfined and at a density greater than 1.1 gm./cc., it may be detonated by a No. 6 blasting cap.

5. A cap sensitive ammonium nitrate blasting explosive of the safety type including as the principal explosive ingredient an intimate admixture of about 90% to about 98% of ammonium nitrate and about 2% to about 10% of a non-explosive carbonaceous sensitizer, the said intimate admixture comprised of particles a major portion of which have a diameter less than 200 microns and characterized by a sensitiveness such that, when unconfined and at a density greater than 1.1 gm./cc., it may be detonated with a No. 10 blasting cap.

6. A cap sensitive ammonium nitrate blasting explosive of the safety type including as the principal explosive ingredient an intimate admixture comprising essentially an admixture of about 90% to about 98% of ammonium nitrate and about 2% to about 10% of a non-explosive carbonaceous sensitizer, the said intimate admixture comprised of particles a major portion of which have a diameter less than 100 microns and characterized by a sensitiveness such that, when unconfined and at a density greater than 1.1 gm./cc., it may be detonated by a No. 6 blasting cap.

7. A cap sensitive ammonium nitrate blasting explosive of the safety type which includes a blend comprising discrete particles of ammonium nitrate of a screen size between about 10 mesh and 60 mesh and of an intimate admixture comprising essentially ammonium nitrate and a non-explosive carbonaceous sensitizer, said discrete particles present in an amount not exceeding 50% of the weight of the total explosive, and the said intimate admixture comprised of particles a major portion of which have a diameter less than 200 microns and present in amount sufficient for the said blasting explosive to be characterized by a sensitiveness such that, when unconfined and at a density of 1.1 gm./cc., it may be detonated with a No. 10 blasting cap.

8. A cap sensitive ammonium nitrate blasting explosive of the safety type which includes a blend comprising in approximately equal proportions discrete particles of ammonium nitrate of a screen size between about 10 mesh and 60 mesh and an intimate admixture comprising essentially ammonium nitrate and a non-explosive canbonaceous sensitizer, the said intimate admixture comprised of particles a major portion of which have a diameter less than 100 microns and the said blasting explosive characterized by a sensitiveness such that, when unconfined and at a density of 1.1 gm./cc., it may be detonated with a No. 6 blasting cap.

9. A cap sensitive ammonium nitrate blasting explosive of the safety type which includes a blend comprising discrete particles of ammonium nitrate of a screen size between about 10 mesh and 60 mesh and of an intimate admixture comprising essentially ammonium nitrate and a substantially petroleum hydrocarbon insoluble resin, said discrete particles present in an amount not exceeding 50% of the weight of the total explosive, and the said intimate admixture comprised of particles a major portion of which have a diameter less than 200 microns and present in amount sufficient for the said blasting explosive to be characterized by a sensitiveness such that, when unconfined and at a density of 1.1 gm./cc., it may be detonated with a No. 10 blasting cap.

10. A cap sensitive ammonium nitrate blasting explosive of the safety type which includes a blend comprising in approximately equal proportions discrete particles of ammonium nitrate of a screen size between about 10 mesh and 60 mesh and an intimate admixture comprising essentially ammonium nitrate and a substantially petroleum hydrocarbon insoluble resin, the said intimate admixture comprised of particles a major portion of which have a diameter less than 100 microns and the said blasting explosive characterized by a sensitiveness such that, when unconfined and at a density of 1.1 gm./cc., it may be detonated with a No. 6 blasting cap.

11. A cap sensitive ammonium nitrate blasting explosive of the safety type which includes a blend comprising discrete particles of ammonium nitrate of a screen size between about 10 mesh and 60 mesh and of an intimate admixture comprising essentially about 90% to about 98% of ammonium nitrate and about 2% to about 10% of a non-explosive carbonaceous sensitizer, said discrete particles present in an amount not exceeding 50% of the weight of the total explosive, and the said intimate admixture comprised of particles a major portion of which have a diameter less than 200 microns and present in amount sufficient for the said blasting explosive to be characterized by a sensitiveness such that, when unconfined and at a density of 1.1 gm./cc., it may be detonated with a No. 10 blasting cap.

12. A cap sensitive ammonium nitrate blasting explosive of the safety type which includes a blend comprising in approximately equal proportions, discrete particles of ammonium nitrate of a screen size between about 10 mesh and 60 mesh and at least about 50% of an intimate admixture comprising essentially about 90% to about 98% of ammonium nitrate and about 2% to about 10% of a non-explosive carbonaceous sensitizer, the said intimate admixture comprised of particles a major portion of which have a diameter less than 100 microns and the said blasting explosive characterized by a sensitiveness such that, when unconfined and at a density of 1.1 gm./cc., it may be detonated with a No. 6 blasting cap.

13. A blasting explosive comprising a substantially dry intimate mixture of a predominating proportion of ammonium nitrate and a substantially small proportion of a solid combustible material, the particles of such mixture being sufficiently finely divided to render the explosive sensitive to detonation by a commercial blasting cap, and the major portion of said particles being capable of passing through a screen of the order of 200 mesh.

14. A blasting explosive comprising a substantially dry intimate mixture of a predominating proportion of ammonium nitrate and a substantially small proportion of a solid combustible material, the particles of such mixture being sufficiently finely divided to render the explosive sensitive to detonation by a No. 6 blasting cap, and the major portion of said particles being less than 100 microns in diameter.

15. A blasting explosive comprising a substantially dry intimate mixture of a predominating proportion of ammonium nitrate and a substantially small proportion of a solid combustible material, the particles of such mixture being sufficiently finely divided to render the explosive sensitve to detonation by a No. 10 blasting cap, and the major portion of said particles being less than 200 microns in diameter.

16. A blasting explosive comprising a substantially dry intimate mixture containing from about 90% to about 98% of ammonium nitrate and from about 2% to about 10% of solid combustible material, the particles of such mixture being sufficiently finely divided to render the explosive sensitive to detonation by a commercial blasting cap, and the major portion of said particles being capable of passing through a screen of the order of 200 mesh.

17. A blasting explosive comprising a substantially dry intimate mixture containing from about 90% to about 98% of ammonium nitrate and from about 2% to about 10% of solid combustible material, the particles of such mixture being sufficiently finely divided to render the explosive sensitive to detonation by a No. 6 blasting cap, and the major portion of said particles being less than 100 microns in diameter.

18. A blasting explosive comprising a substantially dry intimate mixture containing from about 90% to about 98% of ammonium nitrate and from about 2% to about 10% of solid combustible material, the particles of such mixture being sufficiently finely divided to render the explosive sensitive to detonation by a No. 10 blasting cap, and the major portion of said particles being less than 200 microns in diameter.

WILLIAM M. COBB, JR.

CERTIFICATE OF CORRECTION.

Patent No. 2,324,363. July 13, 1943

WILLIAM M. COBB, JR.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 5, first column, line 68, claim 12, strike out "at least about 50% of"; Page 3, second column, line 59, for "or" read --of--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 7th day of September, A. D. 1943.

Henry Van Arsdale,
Acting Commissioner of Patents.

(Seal)

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(Seal)