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EXPLOSIVE SYSTEM CONTAINING AMMONIUM NITRATE

Original Filed June 21, 1957

2 Sheets-Sheet 1

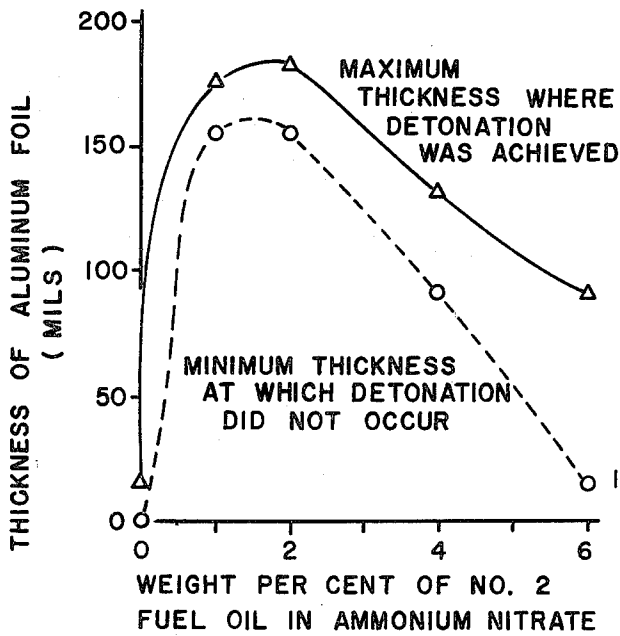


FIGURE 3

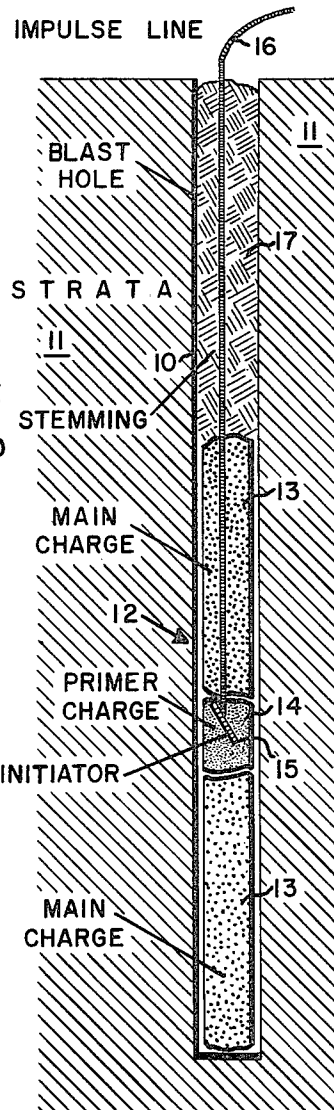


FIGURE 1

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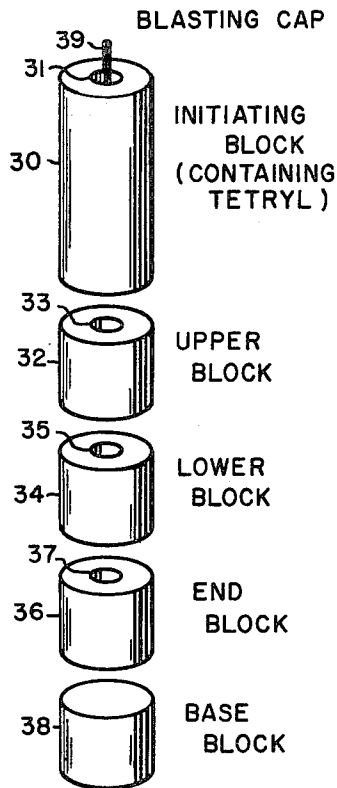


FIGURE 4

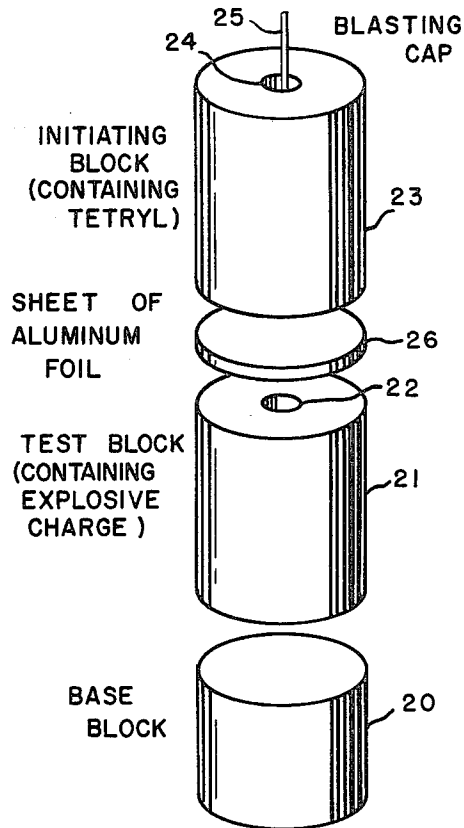


FIGURE 2

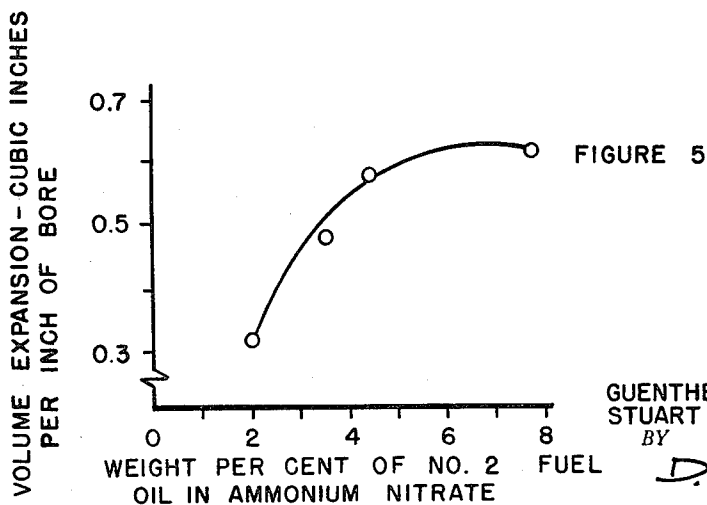


FIGURE 5

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EXPLOSIVE SYSTEM CONTAINING AMMONIUM NITRATE

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Original application June 21, 1957, Ser. No. 667,141. Divided and this application July 7, 1958, Ser. No. 747,047

8 Claims. (Cl. 102--22)

The present invention relates to a complete explosive system and a method for generating explosions therefrom. More particularly, the invention relates to explosive systems comprising ammonium nitrate and liquefiable hydrocarbons.

The present application is a division of copending application S.N. 667,141, filed June 21, 1957, now abandoned, entitled "Explosive Compositions Containing Ammonium Nitrate," by S. R. Brinkley, Jr., and Guenther von Elbe, and assigned to the assignee of the present invention.

The explosive properties of ammonium nitrate have been known for many years. Ammonium nitrate has been used as an industrial explosive alone and in combination with organic combustible materials such as carbon black. These ammonium nitrate explosives do not possess cap-sensitivity and hence require for detonation powerful primer charges of cap-sensitive explosives such as dynamite. In practice, a blasting cap or detonating fuse is employed as an initiator to detonate the dynamite which in turn detonates the less sensitive ammonium nitrate charge. Frequently the primer charge comprises 10 percent and more of the weight of the total blasting charge.

The use of cap-sensitive explosives such as dynamite is disadvantageous in that such materials usually are significantly more expensive than the main explosive charge which is principally ammonium nitrate, a cheap chemical of commerce. Moreover, the likelihood of misfires introduces hazards in that the misfired planted charge may be detonated through accident when the strata is later worked by earth moving equipment such as shovels.

The principal object of this invention is to provide an explosive system which is relatively inexpensive and which avoids the explosive hazards resulting from misfires.

A further object of this present invention is to provide a cap-sensitive explosive composition comprising ammonium nitrate and liquefiable hydrocarbons which has sufficient explosive power to detonate a cap-insensitive explosive composition.

Another object of this invention is to provide an explosive system comprising a main charge of ammonium nitrate and liquefiable hydrocarbons which is cap-insensitive and a primer charge of ammonium nitrate and liquefiable hydrocarbons which is cap-sensitive.

Another object of this invention is to provide a method for preparing explosive compositions having cap-sensitivity from ammonium nitrate and liquefiable hydrocarbons.

Another object of this invention is to provide a method for generating explosions from a blasting cap or detonating fuse with an explosive charge comprising ammonium nitrate and liquefiable hydrocarbons.

We have made two discoveries which form the basis of the present invention.

First, we have found that a cap-sensitive explosive composition can be prepared by homogeneously intermixing finely divided ammonium nitrate with 0.5 to 3.5 percent by weight of liquefiable hydrocarbons. Such compositions can be detonated by a blasting cap or detonating fuses. These compositions possess sufficient explosive power to detonate a main explosive charge which is cap-insensitive. Accordingly, such explosive compositions

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can be employed as primer charges in an explosive system to detonate a main charge of more powerful explosive properties.

Secondly, we have found that the explosive power of mixtures of finely divided ammonium nitrate and liquefiable hydrocarbons is maximized in compositions containing about 4 to 8 percent of liquefiable hydrocarbons. Thus an explosive composition suitable for use as a main explosive charge can be prepared from finely divided ammonium nitrate and about 4 to 8 percent by weight of liquefiable hydrocarbons. When the liquefiable hydrocarbons are present in quantities of less than about 4 percent and greater than about 8 percent by weight, the explosive power potential of the composition is not realized. Moreover, compositions containing more than about 8 percent of liquefiable hydrocarbons are so insensitive that the likelihood of misfire increases.

By combining these two discoveries we have developed a novel explosive system in which both the primer charge and the main explosive charge are comprised of finely divided ammonium nitrate and liquefiable hydrocarbons. An ordinary blasting cap or length of detonating fuse can be employed to initiate a powerful explosion in this system. Throughout this specification and claims, the term "cap-sensitive" is used to designate that property of explosive compositions enabling their detonation with blasting caps or detonating fuse such as Primacord.

Ammonium nitrate and liquefiable hydrocarbons are quite cheap in contrast to conventional manufactured explosives. Hence the overall explosive cost is greatly reduced when this new system is employed. Moreover, the hazards usually inherent in misfired shots are minimized with the present explosive system in that its components are quite insensitive in contrast to conventional primer charges such as dynamite.

The cap-sensitive explosive composition of this invention of course can be utilized as a primer charge for other types of bulk explosives than those specifically described herein. Hence the cap-sensitive explosive composition has utility apart from its use in combination with a cap-insensitive main charge comprising ammonium nitrate. The preferred system, as described, uses compositions of ammonium nitrate and liquefiable hydrocarbons or both primer charge and main blasting charge. With this system, the blasting operator needs to purchase only inexpensive bulk chemicals and initiators.

(I) AMMONIUM NITRATE

Ammonium nitrate is a widely used agricultural chemical. For agricultural use as fertilizer, the ammonium nitrate is formed into prills which are spherical particles created by fusing drops of molten ammonium nitrate. In prill form, the ammonium nitrate is fragile and hygroscopic. Ordinary handling of the ammonium nitrate prills during transportation results in attrition and physical degradation. Exposure to moisture during transportation and storage results in caking of the prills and loss of their free-flowing properties. To avoid caking and attrition, the manufacturers of ammonium nitrate prills frequently provide a thin coating of clay or diatomaceous earth over the surface of the ammonium nitrate prills. The clay-coating avoids caking of the material during storage and also minimizes the attrition of the ammonium nitrate. For agricultural chemical use, the presence of a clay-coating is innocuous. Ammonium nitrate also can be obtained in crystalline and flake form.

We prefer to use the ammonium nitrate in the commercially available prill form, although the prills may be comminuted, if desired. The presence of the clay-coating on the prills does not interfere with the preparation of a main explosive composition having 4 to 8 percent by weight of liquefiable hydrocarbons provided that

a homogeneous absorption of the hydrocarbons into the prills is achieved. In preparing the cap-sensitive explosive composition of this invention, however, the presence of a clay-coating on the prills interferes with obtaining cap-sensitivity. Accordingly, the cap-sensitive explosive composition containing 0.5 to 3.5 percent by weight of liquefiable hydrocarbons is prepared from uncoated prills. During transportation, the uncoated prills can be protected against caking by shipment in moisture-proof containers. Ordinary handling during transportation and storage will effect some attrition of the prills which increases the exposed surface area. Comminution of the uncoated prills by milling, for example, increases the sensitivity of explosive compositions prepared therefrom. We have found, however, that cap-sensitive compositions can be prepared from the prills as received from the manufacturer. Such prills usually are of a size which will pass through about an 8-mesh screen.

(II) HYDROCARBONS

The hydrocarbons employed in the present explosive composition should be in liquid form during the preparation of the composition. Any hydrocarbon which can be mixed in a liquid condition is suitable. In general we prefer to use a hydrocarbon which is not readily vaporized at the ambient temperature of storage. Hence we prefer to use normally liquid hydrocarbons. As a further precaution we prefer to employ hydrocarbons having a flash point above about 100° F. No. 2 fuel oil meets all these requirements and is a preferred ingredient. Its specifications are well-known and are set forth in the U.S. Department of Commerce Commercial Standard CS 12-48. No. 2 fuel oil has a flash point above 100° F. and a 90% distillation point of 675° F. Its maximum Saybolt Universal viscosity at 100° F. is 125 seconds.

The hydrocarbons can be of any chemical characterization, to wit, paraffinic, olefinic, naphthenic, aromatic, saturated or unsaturated. Hydrocarbons which are highly viscous at atmospheric temperatures can be heated to promote fluidity for preparing compositions.

Homogeneous mixing of the hydrocarbon and ammonium nitrate requires that the hydrocarbon actually penetrate the particles of ammonium nitrate. Since this is an absorption process, an extrinsic period of contact may be required. A convenient manner for mixing the materials is to tumble the ingredients in a rotating mill for several hours.

For a further understanding of the present invention, its objects and advantages, reference should be had to the accompanying drawings in which:

FIGURE 1 is a cross-section through a prepared blast hole in a rock strata containing an explosive system according to the present invention;

FIGURE 2 is an illustration of apparatus adapted to obtain sensitivity information on explosive compositions;

FIGURE 3 is a graphical representation of the results of a series of sensitivity investigations conducted with explosive compositions according to the present invention;

FIGURE 4 is an illustration of apparatus adapted to compare explosive power of compositions according to the present invention; and

FIGURE 5 is a graphical representation of the results of a series of explosive power investigations conducted with explosive compositions according to the present invention.

(III) BLASTING SYSTEM

Referring to FIGURE 1, a blast hole 10 is provided in a strata 11. An explosive charge 12 (representing the entire charge) is deposited within the blast hole 10.

The explosive charge 12 comprises an elongated container having a main explosive charge 13 at each end thereof and a primer charge 14 within the main blasting charge 13. An initiator 15 such as a blasting cap or length of detonating fuse is provided in detonating rela-

tionship with the primer charge 14. An impulse line 16 extends from the initiator 15 to the blasting control point. The impulse line 16 may comprise electrical wire in the event electric detonation is used or may be a length of detonating fuse such as Primacord.

Stemming material 17 is provided for confining the explosive charge 12 within the blast hole 10. The stemming material usually consists of twigs, clay, rocks and other available material, conveniently the cuttings from the drilled blast hole.

According to the present invention, the main blasting charge 13 comprises a mixture of ammonium nitrate and 4 to 8 percent by weight of hydrocarbons. Such a composition has a satisfactory explosive power but is not cap-sensitive. The primer charge 14 comprises a mixture of ammonium nitrate in comminuted condition with 0.5 to 3.5 percent by weight of hydrocarbons. Such mixtures possess cap-sensitivity. While the primer charge 14 does not possess the explosive power of the main blasting charge 13, nevertheless, sufficient explosive power exists for detonating the main blasting charge 13.

We have illustrated in FIGURE 1 one form in which the present invention may be employed. The manner of loading blast holes forms no part of the present invention. Various loading techniques are well-known in the art for achieving optimum results in differing strata. For our explosive system, the essential features are providing a main explosive charge in detonating relation to a primer charge and providing a detonation initiator in detonating relation to the primer charge. Hence the primer charge need not be at the center of the main blasting charge as illustrated in FIGURE 1. The primer charge could be at the top or bottom of the blast hole. It may be of advantage to use several primer charges in a blast hole.

Preferably the explosive compositions are confined in flexible containers such as moisture-proof bags of canvas or plastic film. Fiber or metal cylinders also may be employed. Where the blast hole is dry and relatively free of fissures, the composition may be poured directly into the blast hole.

(IV) SENSITIVITY TESTS

In order to demonstrate the range of cap-sensitivity for ammonium nitrate and hydrocarbon mixtures, a series of tests was conducted with uncoated ammonium nitrate prills as received from a supplier. The liquid hydrocarbon was No. 2 fuel oil. An ad hoc test was devised to provide relative sensitivity measurement.

The apparatus for conducting the ad hoc tests is illustrated in FIGURE 2 which will be described.

Referring to FIGURE 2, the testing structure comprises three steel blocks.

The base block 20 is a heavy steel block which is solid and serves merely as a support. The central block 21 has a 1/8-inch diameter bore 22 extending vertically therethrough. The bore 22 is filled with the explosive charge under investigation. The upper block 23 similarly has a 1/8-inch diameter bore 24 extending therethrough which can be aligned with the bore 22 of the central block 21. The bore 24 of the upper block 23 is filled with a powerful primer explosive. For the present tests, the primer employed was tetryl. A blasting cap 25 is provided in detonating relationship with the tetryl charge to initiate an explosion.

Between the upper block 23 and the central block 21 a sheet of aluminum foil 26 is provided.

In each test, a constant weight charge of tetryl is detonated in the upper block 23. If the sheet of aluminum foil 25 is sufficiently thin, the tetryl explosion will detonate the explosive charge confined in the central block 21. Extremely sensitive explosive charges in the central block 21 can be detonated in this test with thick sheets of aluminum foil 25 between the blocks. Relatively insensitive explosive charges in the central block 21 will not

be detonated even with thin sheets of aluminum foil 25 between the blocks. Accordingly, the index of sensitivity is that thickness of aluminum foil 25 which will permit propagation of the tetryl explosion into the explosive charge under investigation in the central block.

An extensive series of tests was conducted in the apparatus illustrated in FIGURE 2 with explosive composition prepared for screened ammonium nitrate particles (comminuted prills) passing through a 30 mesh screen and retained on a 100 mesh screen. The liquid hydrocarbon was No. 2 fuel oil. Tests were conducted with compositions having 0, 1, 2, 4, and 6 percent by weight of fuel oil homogeneously mixed with the screened ammonium nitrate. For each composition under investigation, we have recorded two values in the following Table I. The first value is that maximum thickness of aluminum foil (in mils) at which detonation occurred in the apparatus shown in FIGURE 2. The second figure recorded is that minimum thickness of aluminum foil (in mils) at which detonation did not occur in the apparatus shown in FIGURE 2.

Table I.—Sensitivity Tests

Explosive Compositions—Wt. Percent No. 2 Fuel Oil	Aluminum Foil Thickness (Mils)	
	Maximum at Which Detonation Occurred	Minimum at Which Detonation Did Not Occur
0-----	16	0
1-----	175	155
2-----	182	155
4-----	131	91
6-----	91	16

The data presented in Table I are presented graphically in FIGURE 3 which illustrates the relationship between aluminum foil thickness (as a parameter of sensitivity) to the concentration of No. 2 fuel oil in ammonium nitrate as an explosive composition. Both the maximum and minimum aluminum foil thicknesses have been plotted.

The points of maximum thickness (represented by triangles) have been joined by a solid line. The points of minimum thickness (represented by circles) have been joined by a broken line. A precise curve for sensitivity would lie between the two plotted lines of FIGURE 3.

While recognizing that the graph in FIGURE 3 has little value from a quantitative standpoint, nevertheless, it serves to illustrate the relative sensitivity of various explosive compositions. It can be seen from inspection of FIGURE 3 that maximum sensitivity occurs when an ammonium nitrate composition contains 0.5 to 3.5 percent by weight of No. 2 fuel oil.

(V) EXPLOSIVE POWER TESTS

In order to compare the relative explosive power of compositions containing ammonium nitrate and liquid hydrocarbons, we have devised an ad hoc test in apparatus which is illustrated in FIGURE 4. As shown in FIGURE 4, five steel blocks are provided. An initiating block 30 was 16-inches long and had a one-inch diameter bore 31. An upper block 32 was 6-inches high and had a one-inch diameter bore 33. A lower block 34 was six-inches high and had a one-inch diameter bore 35. An end block 36 was six-inches high and had a one-inch diameter bore 37. A base block 38 was a solid steel plate serving as a support. The five blocks were assembled as shown and the bores 31, 33, 35 and 37 were aligned.

In each test an explosive composition containing ammonium nitrate and No. 2 fuel oil was introduced into the bores 37, 35 and 33 of the end block 36, the lower block 34, the upper block 32 and into the lower 12-inches of the bore 31 of the initiating block 30. A charge of tetryl was provided in the upper four-inches of the bore 31 of the initiating block 30. A blasting cap 39 was provided in detonating relationship with the tetryl charge.

As an indication of explosive power we measured the expansion of the bore 35 in the lower block 34 following detonation. The function of the end block 36 was to prevent any end effects of detonation from affecting the measurements of the expanded bore 35 in the lower block 34.

An extensive series of tests was conducted with ammonium nitrate and hydrocarbon compositions containing 2.0, 3.5, 4.4 and 7.7 percent by weight of No. 2 fuel oil. The ammonium nitrate was used in the form of clay coated prills as received from a supplier.

By providing impulse recording devices above the upper block 32 and below the lower block 34, we were also able to measure the rate of explosive propagation for each of the charges under investigation.

The following Table II presents the results of a series of tests in apparatus as shown in FIGURE 4.

Table II.—Relative Explosive Power

Explosive Composition—Wt. Percent No. 2 Fuel Oil In Ammonium Nitrate	Rate of Propagation, Feet Per Second	Bore Expansion of Lower Block, Inches	Volume Expansion ¹
2.0-----	8,600	0.185	0.317
3.5-----	12,200	0.270	0.481
4.4-----	10,700	0.317	0.576
7.7-----	10,400	0.340	0.625

¹ Cubic inches of expansion per inch of bore.

Data presented in Table II have been plotted graphically in FIGURE 5. The volume expansion factor is a criterion of explosive power of the compositions under investigation. As shown in FIGURE 5, the expansion (hence explosive power) exhibits a maximum volume in the range from about 4 to 8 percent of oil in ammonium nitrate.

For the explosive system of the present invention, compositions containing more than about 8 percent by weight of oil are sufficiently insensitive that detonation could not be assured by the use of the ammonium nitrate and oil cap-sensitive primer charge provided in the system. Accordingly, we prepare a main explosive charge from ammonium nitrate and liquid hydrocarbons having from 4 to 8 percent by weight of the hydrocarbon. Such compositions provide a maximum explosive power. While cap-insensitive, they nevertheless possess sufficient sensitivity to be detonated by the cap-sensitive primer charge described herein.

(VI) EFFECT OF COMMUNITION

To illustrate the improvements resulting from comminution of the ammonium nitrate on the detonation sensitivity of the mixtures, a series of charges was prepared in half-pint quantities and placed in cardboard cylindrical containers. The containers were placed on lead blocks of 1.5 inches diameter and 2.5 inches height. The initiators were affixed and each charge detonated. The depression in the lead block following detonation measured the strength of detonation. The response to the initiator measured the sensitivity of the mixtures, i.e., did the mixture detonate or not. The results of these tests are set forth in the following Table III.

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Table III

Explosive Mixture		Initiator	Lead Block Depression, Inches
Ammonium Nitrate	No. 2 Fuel Oil, Percent		
A. Coated prills.....	6	Engineer's cap.....	(1)
B. Coated prills.....	2	No. 8 cap.....	(1)
C. Uncoated prills (as received),	2	60 grain Primacord.	1.3
D. Uncoated prills (Milled for 5 minutes),	2	do.....	1.7
E. Uncoated prills (Milled for 15 minutes),	2	do.....	1.9
F. Uncoated prills (Milled for 45 minutes),	2	do.....	1.9
G. Uncoated prills (Milled through 16 mesh on 20 mesh screen),	2	No. 6 cap.....	0.15
H. Uncoated prills (Milled through 200 mesh screen),	2	do.....	1.9

¹ No reaction.

Tests A and B indicated that coated prills are insensitive to cap detonation when combined with No. 2 fuel oil as a composition. Tests G and H indicate that a cap-sensitive explosive composition can be obtained with uncoated ammonium nitrate prills and 2 percent by weight of No. 2 fuel oil. Detonation was obtained in tests C, D, E and F and 60 grain Primacord (a detonating fuse). The comparative quantitative values of the lead block depression measurements indicates that the strength of detonation can be increased by reduction of the particle size of the ammonium nitrate.

(I) TESTS WITH UNCOATED PRILLS

A composition containing uncoated ammonium nitrate prills and 2 percent by weight of No. 2 fuel oil was prepared. The cardboard cylinders were detonated with 50 grain Primacord and also with 100 grain Primacord.

(II) TESTS WITH COMMINUTED UNCOATED PRILLS

Comminuted prills were screened through a 60 mesh screen on an 80 mesh screen and mixed with 2 percent by weight of No. 2 fuel oil. The cardboard cylinders were detonated with 40 grain Primacord and 100 grain Primacord.

Comminuted prills were screened through a 100 mesh screen and mixed with 2 percent by weight of No. 2 fuel oil. The cardboard cylinders were detonated with 50 grain Primacord.

These cardboard cylinder tests are presented as an illustration of the cap-sensitivity (i.e., cap and detonating fuse sensitivity) of the explosive compositions containing 0.5 to 3.5 percent by weight of liquefiable hydrocarbons.

For ammonium nitrate prills as received from commercial suppliers we prefer to prepare our cap-sensitive explosive composition containing about 1.5 to 3.0 percent of liquefiable hydrocarbons. Where the prills are comminuted prior to mixing with hydrocarbons, cap-sensitivity of the product can be achieved with over the slightly wider range of 0.5 to 3.5 percent of liquefiable hydrocarbons.

(VII) ILLUSTRATION

To illustrate the explosive system of the present invention, two explosive charges were prepared in ½-inch thick steel cylinders having a 4-inch inner diameter and a 36-inch length.

First charge.—The main explosive charge comprised a 6 percent mixture of No. 2 fuel oil and clay coated ammonium nitrate prills. The cylinder was filled to a depth of 16-inches with this mixture. Thereafter a 4-inch charge of tetryl was placed in the cylinder as a primer charge. Tetryl is a commonly used commercial primer charge comprising trinitrophenylmethylnitramine. A No. 8 blasting cap was installed in the tetryl charge and the cylinder was filled with the described 6 percent mixture of ammonium nitrate and No. 2 fuel oil.

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On detonation an explosion velocity of 11,100 feet per second was recorded.

Second charge.—A steel cylinder was filled to a depth of 16-inches with the described 6 percent mixture of clay coated ammonium nitrate prills and No. 2 fuel oil. Thereafter a 4-inch charge of a 2 percent mixture of No. 2 fuel oil and uncoated ammonium nitrate prills (as received from the manufacturer) was added as a primer charge. A No. 8 blasting cap was installed in contact with the primer charge and the cylinder was filled with the described 6 percent mixture of ammonium nitrate and No. 2 fuel oil.

On detonation an explosion velocity of 11,100 feet per second was recorded.

Comparison of the last two tests indicates the utility of the present invention.

We have also made an ancillary discovery in the course of these investigations concerning the ability of normally liquid hydrocarbons to prevent caking of ammonium nitrate. The hygroscopic properties of ammonium nitrate are well known. Exposure of uncoated ammonium nitrate to atmospheric conditions quickly results in caking of the material.

We have mixed ammonium nitrate prills (uncoated) with 2 percent of No. 2 fuel oil and exposed the composition to the atmosphere for two weeks. No evidence of caking was observed. The prills were free-flowing throughout the two-week period and thereafter.

According to the provisions of the patent statutes, we have explained the principle, preferred construction, and mode of operation of our invention and have illustrated and described what we now consider to represent its best embodiments. However, we desire to have it understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically illustrated and described.

We claim:

1. An explosive system comprising a main explosive charge, a primer charge and an initiator, said main explosive charge being cap-insensitive, said primer charge being sensitive to blasting caps and detonating fuse initiators and consisting essentially of finely divided ammonium nitrate homogeneously admixed with 0.5 to 3.5 percent by weight of liquefiable hydrocarbons, said ammonium nitrate before admixture with said hydrocarbons being free of any coating and of any particles smaller than 100 mesh, said initiator being in detonating relation with said primer charge, and said primer charge being in detonating relation with said main charge.

2. The explosive system of claim 1 wherein the ammonium nitrate is in the form of prills.

3. An explosive system comprising a main explosive charge, a primer charge and an initiator, said main explosive charge being insensitive to blasting caps and detonating fuse initiators and comprising finely divided ammonium nitrate homogeneously admixed with 4 to 8 percent by weight of liquefiable hydrocarbons, said primer charge being sensitive to blasting caps and detonating fuse initiators and consisting essentially of finely divided ammonium nitrate homogeneously admixed with 0.5 to 3.5 percent by weight of hydrocarbonaceous liquid, said ammonium nitrate before admixture with said liquid being free of any coating and of any particles smaller than 100 mesh, said initiator being in detonating relation with said primer charge, and said primer charge being in detonating relation with said main charge.

4. The explosive system of claim 3 wherein the liquefiable hydrocarbon employed is a normally liquid hydrocarbon.

5. The explosive system of claim 3 wherein the hydrocarbonaceous liquid employed is a hydrocarbon distillate having a flash point above 100° F.

6. The explosive system of claim 3 wherein the hydrocarbonaceous liquid employed is No. 2 fuel oil.

7. An explosive system comprising a main explosive

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charge, a primer charge, and a detonating fuse initiator, said primer charge being sensitive to detonating fuse initiators and consisting essentially of ammonium nitrate admixed with 0.5 to 3.5 percent by weight of a hydrocarbonaceous liquid, said ammonium nitrate before admixture with said liquid being free of any coating and of any particles smaller than 100 mesh, said detonating fuse initiator being in detonating relation with said primer charge and said primer charge being detonatably associated with said main charge.

8. An explosive system consisting essentially of an ammonium nitrate and liquefiable hydrocarbon charge and a detonating fuse initiator, a first portion of said charge consisting essentially of finely divided ammonium nitrate admixed with 0.5 to 3.5 percent by weight of liquefiable hydrocarbons and the remainder of said charge consisting essentially of finely divided ammonium nitrate admixed with 4 to 8 percent by weight of liquefiable hydrocarbons,

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said ammonium nitrate before admixture with said hydrocarbons being free of any coating and of any particles smaller than 100 mesh, said detonating fuse initiator in detonating relation with said charge first portion, and said charge first portion being in detonating relation with the remainder of said charge.

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