MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS - 1965 -
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Patents Act

APPLICATION FOR

EXCOA, INC.

York Center,
Willows Road, N.E. 116th Street,
Redmond, Washington 98052,
United States of America.

hereby apply for the grant of a Patent for an invention entitled

TWO COMPONENT FIELD MIX EXPLOSIVE

which is described in the accompanying COMPLETE specification.

(Note: The following paragraph applies only to Convention applications)

This application is a Convention application based on the basic application(s) for a patent or similar protection identified by number, country, and filing date as follows:

596763 July 17, 1975 United States of America.

Address for Service: PHILLIPS ORMONDE AND FITZPATRICK
Patent and Trade Mark Attorneys
37-41 Queen Street
Melbourne, Australia

Dated June 30, 1976.

PHILLIPS ORMONDE & FITZPATRICK
Attorneys for:
EXCOA, INC.

David J. Fitzpatrick
DECLARATION FOR A PATENT APPLICATION

In support of the (a) convention application made by
(a) E'COA, INC.

(hereinafter called “applicant(s)”) for a patent (c) for an
invention entitled (d)

TWO COMPONENT FIELD MIX EXPLOSIVE

1550 0/76

I/XXX c BERNARD F. BECKELMAN, President of and c/o
Excoa, Inc., York Center, Willows Road at N.E.
116th Street, Redmond, (W.A.) 98052 United States
of America. Washington

do solemnly and sincerely declare as follows:

1. (or, in the case of an application by a body corporate)
   1. I am/We are authorized to make this declaration on behalf of the applicant(s).

2. (or, where the applicant(s) is/are not the actual inventor(s))
   2. James E. Friant, 12547 S.E. 70th Renton, (W.A.) 98055
      United States of America -and-       
      Marshall E. Klopich, 1061 Shelton Avenue, N.E.
      Renton, (W.A.) 98055, United States of America.
      Washington

   are the actual inventor(s) of the invention and the facts upon which the applicant(s)
   is/are entitled to make the application are as follows:

   Applicant is the assignee of the said invention from
   the actual inventors.

(Note: Paragraphs 3 and 4 apply only to Convention applications)

3. The basic application(s) for patent or similar protection on which the application is based
   is/are identified by country, filing date, and basic applicant(s) as follows:
   (b) United States of America 17 July, 1975 James E. Friant
       and- Marshall E. Klopich

4. The basic application(s) referred to in paragraph 3 hereof was/were the first application(s)
   made in a Convention country in respect of the invention the subject of the application.

Declared at (c) Redmond, Washington U.S.A.
Dated (d) June 24, 1976.

(m) E'COA, INC.

By: /Bernard F. Beckelman,
   President

To: The Commissioner of Patents
CLAIM 1. A two component field mix explosive composition, comprising:

(a) a first solid component selected from a group consisting of:
   (1) ammonium nitrate,
   (2) mixtures of ammonium nitrate with a compatible oxidizer

(b) a second liquid component comprising:
   (1) hydrazine in an amount between two-fifths to two-thirds
       of the total weight of the second component,
   (2) a second ingredient selected from a group consisting
       of water, a compatible liquid fuel and mixtures thereof in an
       amount between half the amount of hydrazine to an amount by weigh-
       moderately greater than the hydrazine, and
   (3) ammonium nitrate in an amount no greater than one-sixth
       of the total weight of the second component,

with the proportion of said second component to the first component being between one to two parts by weight to fifteen parts by weight of the solid component and present in an amount adequate to form an explosive composition.
The following statement is a full description of this invention, including the best method of performing
Background of the Invention

Field of the Invention

This invention relates to a two component explosive composition particularly adapted for field mixing.

Description of the Prior Art

There are in the prior art various two component explosives, in which each component by itself is non-detonable, and the two components can be mixed together to form an explosive composition. Quite commonly one of the components is a solid and the other a liquid, with the mixing being accomplished by pouring the liquid into the solid. One of the most common two component explosives is made by adding about 5% fuel oil to about 95% ammonium nitrate to make an explosive mixture commonly called "ANFO". However, for detonation, this mixture requires a powerful booster and critical diameters of approximately three inches or more.

A common practice is to detonate an explosive in a borehole that is drilled into a ground formation. One method of placing the explosive in the borehole is to prepackage the explosive in a number of elongate tubular packages, and then arrange these packages in end to end relationship to form an explosive train that is inserted into the borehole. A detonator is inserted into the end cartridge to initiate the explosive reaction.
An explosive composition suitable for field mixing and
detonation in boreholes, as described above, is that disclosed
in U.S. Patent No. 3,768,410, issued October 3, 1973 and assigned
to the assignee of the present invention. In this explosive
composition there is a first solid component made up of ammonium
nitrate or mixtures of ammonium nitrate with ammonium perchlorate
or the like, and a second liquid component made up of hydrazine
and water. The ratio of the liquid to solid component is about
one to two parts liquid component to about fifteen parts solid
component, with the preferred ratio being about one to ten. For
maximum safety, the amount by weight of water in the liquid
component is at least about equal to, or slightly greater than,
the amount of hydrazine. This ratio is particularly advantageous
since the hydrazine with at least an equal amount of water can
be shipped by common commercial transportation as a separate
component without hazardous commodity labels, as can the solid com-
ponent which is ammonium nitrate. A package of this explosive
mixture with a diameter down to about one and one-half inches
can be detonated in a borehole by use of a blasting cap.

By way of further background information, in U.S. Patent
No. 3,419,443, Maes, there is disclosed an explosive composition
comprising hydrazinium nitrate, hydrazine and ammonia, with or
without hydrazinium perchlorate. This explosive composition has
been formulated as a two component explosive, where ammonium nitrate
is the solid component and hydrazine is the liquid component,
in a ratio of about two parts solid to one part liquid component.
In some formulations a portion of the ammonium nitrate is
dissolved in the liquid hydrazine in the premix condition. However,
this is done primarily to lower the freezing point of the liquid component. A second reason for doing this is that adding hydrazine to ammonium nitrate gives off gaseous ammonia which can cause the mixture to foam or bubble to an undesired extent. By premixing some of the ammonium nitrate with the hydrazine, some of the ammonia can be boiled off in the preparation of the premix components, so that this foaming can be reduced in the mixing of the two components to make the explosive composition. Other related patents are Audrieth et al, U.S. Patent No. 2,943,927; Audrieth et al, U.S. Patent No. 2,704,706; Hradel, U.S. Patent No. 3,124,495; Stengel, U.S. Patent No. 2,978,864; Stengel et al, U.S. Patent No. 3,061,489; and Rank et al, U.S. Patent No. 3,558,749.

Summary of the Invention

The present invention is an adaptation of the explosive composition disclosed in the above mentioned U.S. Patent No. 3,768,410, and is especially adapted for simple field mixing and reliable detonation in boreholes down to about one inch in diameter.

Accordingly there is provided a two component field mix explosive composition, comprising:

(a) a first solid component selected from a group consisting of:

(1) ammonium nitrate,
(2) mixtures of ammonium nitrate with a compatible oxidizer salt, with the amount of ammonium nitrate being at least half the total weight of the first component,

(b) a second liquid component comprising:

(1) hydrazine in an amount between two-fifths to
two-thirds of the total weight of the second component,

(2) a second ingredient selected from a group consisting of water, a compatible liquid fuel and mixtures thereof in an amount between half the amount of hydrazine to an amount by weight moderately greater than the hydrazine, and

(3) ammonium nitrate in an amount no greater than one-sixth of the total weight of the second component,

with the proportion of said second component to the first component being between one to two parts by weight to fifteen parts by weight of the solid component and present in an amount adequate to form an explosive composition. Preferably the ratio of second liquid component to the first solid component is by weight one to eleven. In a preferred formulation, the ratio of ammonium perchlorate to the total mix is between about 0 to 1 part ammonium perchlorate to 5 parts total weight of solid component.
In a specific preferred formulation, the ammonium perchlorate is 10% of the weight of the total solid component.

The liquid component comprises as a first ingredient hydrazine; a second ingredient selected from a group consisting of water, a compatible liquid fuel ingredient, desirably alcohol, and mixtures thereof; and ammonium nitrate in an amount no greater than about one-sixth of the total weight of the liquid component. Although the amount of ammonium nitrate that is added to the liquid component is only about 1% (or slightly greater) by weight of the final explosive mix, it has been found that with the formulation recited above, the resulting explosive composition is cap sensitive, and can detonate in an explosive column train in a borehole where the explosive is down to about one inch in diameter.

The hydrazine is present in an amount between about two-fifths to about two-thirds of the total weight of the liquid component. The second ingredient (i.e. water, liquid fuel constituent or mixtures thereof) is present in an amount between about one-half the amount of hydrazine and an amount moderately greater than the amount of hydrazine. The ammonium nitrate is present in an amount no greater than about one-sixth of the total weight of the liquid component, and in one preferred formulation is present in about 13% by weight of the total liquid component and in a second preferred formulation is present in about 9% by weight of the total liquid component.

At the location of use, the liquid component is simply poured into the solid component. In the application for which this explosive is especially adapted, the solid component is
contained in its premixed condition in an elongate tubular package, e.g. of diameter no greater than three, preferably 1\(\frac{1}{2}\) inches and as small as one inch in diameter. The liquid component is simply poured into the top end of the package, which is then permitted to set for a short period of time (e.g. five to thirty minutes). The resulting explosive mixture is detonable by itself or in an explosive column train, by means of a blasting cap.

Description of the Preferred Embodiment

The present invention comprises a safe two part explosive adapted for field use, characterized by a solid component, preferably in granular form, and a liquid component.

The solid component is ammonium nitrate, or a mixture of ammonium nitrate with a compatible oxidiser salt, such as ammonium perchlorate (which would include salts having ammonia or a metal as the catanionic radical and nitrate or perchlorate as the anionic radical). For example, ammonium perchlorate can be added to the ammonium nitrate for improved detonation characteristics up to a practical limit of about 50\% by weight of the total weight of the solid component. Additional amounts of ammonium perchlorate increases sensitivity of the explosive to create handling hazards beyond practical commercial standards. In the preferred formulation, the ammonium perchlorate is no greater than about 20\% and desirably about 10\% by weight of the total weight of the solid component. Also, compatible fuel constituents, such as carbon black, sugar, coated aluminum powder or ground up polyethylene can be added, if desired, for
example in an amount of about 10% by weight of the total solid component. While greater amounts can be added, this often times results in incomplete combustion of the added fuel constituents and thus provides no real advantage.

The ammonium nitrate is desirably in the form of prills, such as a standard fertilizer grade prill. Such prills have a very light inorganic coating, e.g. one made up of talc and possibly some other ingredients, which has been found not to impair detonation characteristics of the explosive composition.

Fertilizer grade U.S. Steel prills have been found to be satisfactory. If the ammonium nitrate is too fine (e.g. in powdered form), it is more difficult for the liquid component to flow through the solid component and proper mixing is impaired, particularly in field mix conditions. Ammonium nitrate prills ranging in size where all the prill pass a screen of eight mesh per inch and 94% of which are retained on a screen of twenty mesh per inch have been found to be satisfactory for use in the present invention. The ammonium perchlorate is in granule form of a nominal one hundred mesh size which specifies that 99% of the ammonium perchlorate pass a 65 mesh screen. In finer granule sizes the perchlorate tends to migrate out of the solid component and inhibits mixture.

The liquid component comprises hydrazine as a first ingredient, a second ingredient selected from a group consisting of water, a compatible liquid fuel constituent (desirably alcohol) and mixtures thereof; and a third ingredient which is ammonium nitrate dissolved in the liquid in an amount no greater than about one-sixth of the total weight of the liquid component.
The amount of hydrazine is between two-fifths to two-thirds of the total liquid component by weight. The amount of the second ingredient is between about one-half the amount of hydrazine and an amount moderately greater than the amount of hydrazine. For maximal safety the amount of the second ingredient is by weight at least equal to, or slightly greater than, the amount by weight of hydrazine. This ratio is particularly advantageous since the hydrazine with at least an equal amount of the second ingredient can be shipped by common commercial transportation without hazardous commodity labels. A readily available form of hydrazine is in the form of hydrazine hydrate, which is approximately two parts by weight hydrazine to one part by weight of water. When hydrazine hydrate is used, the water portion of the hydrazine hydrate functions as a part of the second ingredient. Additional amounts of the second ingredient can be added to increase the weight of the second ingredient to slightly greater than the weight of the hydrazine.

It is known that certain aliphatic derivatives of hydrazine, namely, monomethylhydrazine and unsymmetrical dimethylhydrazine and mixture thereof with hydrazine, function in an equivalent manner in explosive compositions and these equivalent compounds are to be considered the equivalents of hydrazine for purposes of practice of the present invention.

In the preferred formulation of the present invention, the second ingredient is made up of water and alcohol, with the amount of water by weight being moderately greater than that of the alcohol. Preferably approximately \( \frac{1}{3} \) of the weight of the second component is water. Since hydrazine hydrate is a readily available form of hydrazine, a convenient method of preparation
of the first two ingredients is to add the alcohol to the hydrazinium hydrate. In one preferred formulation, the proportioning of the hydrazine, water and alcohol is 50 to 29 to 21.

The third ingredient of the liquid component is a small amount of ammonium nitrate dissolved in the first and second liquid ingredients of the liquid component. The amount of ammonium nitrate should be no greater than about one-sixth by weight of the total weight of the liquid component. In one preferred formulation, the amount of ammonium nitrate is 13% by weight of the total liquid component and in a second formulation 9% by weight of the total liquid component. While lesser amounts of ammonium nitrate in the liquid component can be used to produce some desired effect, such lesser amounts are not as effective as those recited above.

Even though the amount of ammonium nitrate added to the liquid ingredient is a very small percentage (in the order of 1% and no greater than 2%) of the total weight of ammonium nitrate in the solid component, it has been found that the addition of this quite small amount of ammonium nitrate to the liquid component significantly enhances the performance of the explosive composition. This particular formulation permits the field mixing of the two components in a configuration where the diameter of the explosive composition is as small as one inch in diameter, with the mixing being able to be reliably accomplished simply by pouring the liquid component into the solid component.

In a typical field use situation, there are a plurality of elongate tubular packages (e.g. approximately one foot long and having a diameter as low as one inch or one and one-quarter inches),
each of which contains the solid component. The proper amount of liquid component is then poured into the upper end of each container, and the container sealed. If the amount of liquid component is too small, it is not sufficient to form a detonable explosive. On the other hand, if the amount of liquid is too great, excess liquid collects in the lower portion of the container and impairs propagation of the explosive reaction. The ratio of the liquid to solid component should be approximately between one to two parts liquid to fifteen parts solid component by weight. In one preferred formulation, the weight of the solid component is 91.5% of the mixed explosive, with the liquid component being 8.5%. The packages of the mixed explosive composition are then stacked in an explosive column train, inserted in a borehole and detonated.

### EXAMPLE I

The solid and liquid components of the explosive composition were formulated separately according to the following formulation.

**Solid Component (% of mixed explosive)**  
- Ammonium Nitrate: 91.5  
- Ammonium Perchlorate: 89.9  
- Inerts: 10

**Liquid Component (% of mixed explosive)** 8.5  
- $N_2H_4$: 43.48  
- $H_2O$: 25.22  
- $CH_3OH$: 18.26  
- Ammonium Nitrate: 13.04
The solid component was placed in a plastic tubular container eleven inches long and one and one-quarter inches in diameter. The top of the container was opened and the liquid component was poured through the open top of the container into the solid component. The container was permitted to remain in an upright position for five minutes. A low power commercial detonator (a DuPont No. 6 blasting cap) was inserted into the explosive mixture at the top part of the container and fired. An explosion occurred and there was full propagation of the explosive reaction throughout the composition.

EXAMPLE II

The same procedure was followed as in Example I, except two tubular packages were prepared and were placed in end to end relationship. Upon firing of the detonator in the uppermost container, full propagation of the explosive reaction proceeded through both containers.

EXAMPLE III

The same procedure was followed as in Example II, except that four containers were placed in end to end relationship in a hole drilled in reinforced concrete. There was full propagation of the explosive reaction and excellent breakup of the concrete.

EXAMPLE IV

The same procedure was followed as in Example I, except that the container was stored for twenty-four hours after mixing
of the two components. There was full propagation of the reaction.

EXAMPLE V

The same procedure was followed as in Example I, except that the container was stored for about four hours after mixing at minus 40°F., and was then successfully fired.

EXAMPLE VI

The same procedure was followed as in Example I, except that the container was stored for about four hours after mixing at 140°F., and was then successfully fired.

EXAMPLE VII

The same procedure was followed as in Example I, except that the ammonium nitrate added to the liquid component was 9% by weight of the total liquid component, with the other ingredients of the liquid component remaining in their same relative ratios. Upon detonation, there was full propagation of the explosive reaction throughout the composition.
The claims defining the invention are as follows:

1. A two component field mix explosive composition, comprising:

   (a) a first solid component selected from a group consisting of:

      (1) ammonium nitrate,

      (2) mixtures of ammonium nitrate with a compatible oxidizer salt, with the amount of ammonium nitrate being at least half the total weight of the first component,

   (b) a second liquid component comprising:

      (1) hydrazine in an amount between two-fifths to two-thirds of the total weight of the second component,

      (2) a second ingredient selected from a group consisting of water, a compatible liquid fuel and mixtures thereof in an amount between half the amount of hydrazine to an amount by weight moderately greater than the hydrazine, and

      (3) ammonium nitrate in an amount no greater than one-sixth of the total weight of the second component,

   with the proportion of said second component to the first component being between one to two parts by weight to fifteen parts by weight of the solid component and present in an amount adequate to form an explosive composition.

2. An explosive composition as recited in claim 1 wherein the compatible oxidizer salt is selected from the group
consisting of salts having ammonia or a metal as the cationic radical and nitrate of perchlorate as the anionic radical.

3. An explosive composition as recited in claim 2 wherein the compatible oxidizer salt is ammonium perchlorate.

4. An explosive composition as recited in any one of the preceding claims, wherein there is 0% to 20% ammonium perchlorate in said first component.

5. An explosive composition as recited in any one of the preceding claims, wherein said first component comprises ammonium nitrate and ammonium perchlorate, with the ratio being one part ammonium perchlorate to nine parts ammonium nitrate.

6. An explosive composition as recited in any one of the preceding claims, wherein the amount of the second ingredient of the second component is at least equal to the amount of hydrazine.

7. An explosive composition as recited in any one of the preceding claims, wherein the second ingredient of the second liquid component comprises water and alcohol.

8. An explosive composition as recited in claim 7, wherein the water is approximately one-quarter by weight of the total weight of the second liquid component, and the remainder of the second ingredient comprises alcohol.
9. An explosive composition as recited in any one of the preceding claims, wherein the ammonium nitrate in the second liquid component is present in an amount no greater than 13% of the second component.

10. An explosive composition as recited in claim 9, wherein the ammonium nitrate in the second liquid component is present in an amount no greater than 9% of the total weight of the second component.

11. An explosive composition as recited in any one of the preceding claims, wherein the ratio of the second liquid component to the first solid component is by weight one to eleven.

12. An explosive composition as recited in any one of the preceding claims, wherein the ammonium nitrate of the first solid component is in the form of prills.

13. An explosive composition as recited in claim 12, wherein said prills are of a size which passes a screen of eight mesh per inch and the majority of which are retained on a screen of twenty mesh per inch.

14. A two component field mix explosive, comprising:
(a) a first elongate tubular container containing a first solid component selected from a group consisting of:
   (1) ammonium nitrate,
   (2) mixtures of ammonium nitrate with a compatible oxidizing salt, with the amount of ammonium
nitrate being at least about half the total weight of the first component,

(b) a second liquid component adapted to be poured into the container for mixing with the first solid component, said liquid component comprising:

(1) hydrazine in an amount between two-fifths to two-thirds of the total weight of the second component,

(2) a second ingredient selected from a group consisting of water, a compatible liquid fuel and mixtures thereof in an amount between half the amount of hydrazine to an amount by weight moderately greater than the hydrazine, and

(3) ammonium nitrate in an amount no greater than one sixth of the total weight of the second component, with the proportion of said second component to the first component being between one to two parts by weight to fifteen parts by weight of the solid component and present in an amount adequate to form an explosive composition.

15. An explosive composition as recited in claim 14 wherein the compatible oxidizer salt is selected from the group consisting of salts having ammonia or a metal as the cationic radical and nitrate or perchlorate as the anionic radical.
16. An explosive composition as recited in claim 14 wherein the compatible oxidizer salt is ammonium perchlorate.

17. An explosive as recited in any one of claims 14 to 16, wherein said container has a diameter no greater than three inches.

18. An explosive as recited in claim 17, wherein said container has a diameter no greater than one and a half inches.

19. An explosive as recited in any one of claims 14 to 18, wherein there is about 0% to 20% ammonium perchlorate in said first component.

20. An explosive as recited in any one of claims 14 to 19, wherein said first component comprises ammonium nitrate and ammonium perchlorate, with the ratio being one part ammonium perchlorate to nine parts ammonium nitrate.

21. An explosive as recited in any one of the claims 14 to 20, wherein the amount of the second ingredient of the second component is at least equal to the amount of hydrazine.

22. An explosive as recited in any one of claims 14 to 21, wherein the second ingredient of the second liquid component comprises water and alcohol.

23. An explosive as recited in claim 22, wherein the water is approximately one-quarter by weight of the total
weight of the second liquid component, and the remainder of the second ingredient comprises alcohol.

24. An explosive as recited in any one of claims 14 to 23, wherein the ammonium nitrate in the second liquid component is present in an amount no greater than about 13% of the second component.

25. The explosive as recited in claim 24, wherein the ammonium nitrate in the second liquid component is present in an amount no greater than about 9% of the total weight of the second component.

26. The explosive as recited in any one of claims 14 to 25, wherein the ratio of the second liquid component to the first solid component is by weight approximately 1 to 11.

27. An explosive as recited in any one of claims 14 to 26, wherein the ammonium nitrate of the first solid component is in the form of prills.

28. An explosive as recited in claim 27, wherein said prills are of a size which passes a screen of eight mesh per inch and the majority of which are retained on a screen of twenty mesh per inch.

29. A two component field mix explosive substantially as hereinbefore described with reference to any one of the examples.

DATED: March 22, 1979

PHILLIPS ORMONDE & FITZPATRICK

BY:

PWJ:CF