

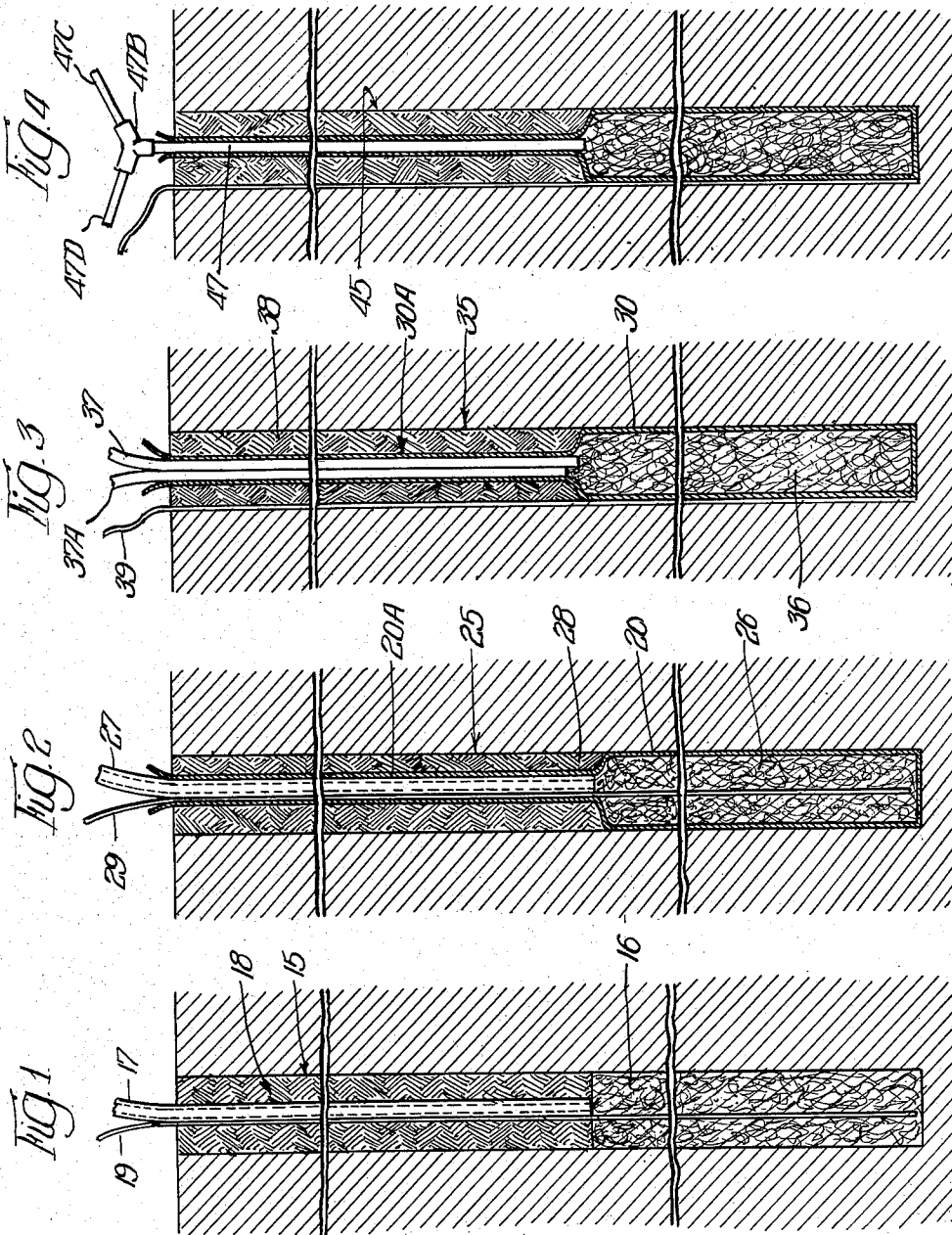
Sept. 15, 1959

F. F. KOLBE

2,903,969

METHOD OF BLASTING

Filed May 28, 1953



INVENTOR.

Frank F. Kolbe

BY

Brown, Jackson, Brettker & Drenner

[Signature]

1

2,903,969

METHOD OF BLASTING

Frank F. Kolbe, Chicago, Ill., assignor, by mesne assignments, to The Maumee Collieries Co., a corporation of Ohio

Application May 28, 1953, Serial No. 358,212

22 Claims. (Cl. 102—23)

This invention relates to a method of handling both liquid and solid ingredients which in combination form an explosive mixture. More particularly, this invention relates to a method of positioning in a blasting hole, having an angle above the horizontal, an explosive mixture of ammonium nitrate, a liquid hydrocarbon and nitrogen tetroxide.

Because of its explosive power, its clean handling properties and its ready availability, ammonium nitrate is a naturally desirable solid component of explosive compositions. In addition to these physical attributes, ammonium nitrate possesses an advantageous chemical attribute in that when detonated it acts both as a fuel and as a source of oxygen. Since in the process of detonation some of this oxygen is in excess, I mix ammonium nitrate with a fuel such as a hydrocarbon.

It is an inherent advantage in composite explosives—those explosives consisting of a plurality of constituents which severally may be non-explosive in nature—that the danger of a premature explosion is minimized or eliminated. There is a problem, however, in working with such a composite explosive, which is a mixture of various constituents, of achieving a uniform intermixing of the components without a considerable degree of handling either of the components as such or of the explosive mixture as formed. Such handling of unstable components or of the final composition obviously increases the possibilities of a premature and uncontrolled detonation. It is readily evident that the only safe explosive is one that is created for the first time in situ. This can be achieved by working with a composite explosive if certain attendant difficulties can be overcome.

There are, however, certain problems peculiar to blasting operations involving the use of such composite explosives, the fundamental problem relating to the bringing together of the several constituents at the desired situs in the blasting hole, and of bringing them together at that point at the desired point of time. To avoid any unnecessary risk, it is advantageous to bring such constituents into suitable admixture as quickly as possible, and as nearly as possible to the given time for detonation. By coordinating this admixture as closely as possible with the time of detonation, any tendency that the material might have to undergo self-detonation is reduced. Furthermore, losses due to volatilization or seepage of the reactant is precluded or minimized.

Accordingly, it is an object of this invention to provide a method for positioning a composite explosive in a blasting hole.

It is a further object to provide a superior method for separately introducing the several liquid and solid constituents of a composite explosive into a blasting hole.

A further object is to provide a safe and practical method for separately introducing the several constituents of a composite explosive into a blasting hole which method will permit optimum intermixing of said constituents.

A further object of the invention is to introduce the

2

liquid constituents into the blast hole in the order of their stability.

The foregoing objects have been achieved by my invention which gains the advantages inherent in a composite explosive while at the same time overcoming the disadvantages. This is accomplished by my method which makes possible the injecting of solid and liquid constituents including the combustibles and oxidants into a drilled blasting hole.

In the drawing:

Figures 1 through 4 illustrate in diagrammatic form four alternative means and methods of packing a drill hole with explosive according to my invention as hereinafter described.

Specifically, my invention comprehends the use of ammonium nitrate, kerosene as the fuel, and nitrogen tetroxide as an additional oxygen source and as a means of introducing sensitivity to the explosive. However, it will be evident from the following description that the invention is broadly applicable in its teachings of handling techniques suitable for other composite explosives containing both solids and liquids. In the particular embodiment described, kerosene is representative of other hydrocarbon fuels such as benzene, nitro-benzene, naphthalene, gasoline, and the like. With regard to the selection of suitable fuels, kerosene appears to be the optimum material under normal conditions because of its greater physical stability, the other materials being somewhat more volatile.

In the initial step of positioning the components in the drilled blasting hole 15 (Fig. 1) according to my techniques, crystalline or pelletized ammonium nitrate 16, which as a clean solid material is safely and easily handled, is poured into the drilled hole. This material falls to the bottom of the hole where, as a crystalline solid, it has a substantial amount of interstitial space between crystals. For example, in commercial grades of ammonium nitrate used for fertilizing soil there may be about 40% voids. Following this, kerosene, gasoline, or others of the aforementioned fuels, or mixtures thereof, are introduced either through a tube 17 which extends into the hole at least as far as the top of the ammonium nitrate accumulation or by merely pouring the kerosene on top of the ammonium nitrate. In this way, the kerosene flows into the interstitial spaces between the particles of ammonium nitrate and coats those particles. Preferably, sufficient kerosene is used that in addition to coating the particles of ammonium nitrate, there is a free amount which occupies a portion of the interstitial spaces.

When a tube is used to introduce the kerosene, it may be either rigid or flexible, or a combination of such types of tubing, since its purpose is to serve as a conduit. The selection of the particular tubing to be used need only be made with regard to the fact that the tubing must be of such nature that its walls will not unduly collapse from the forces imposed upon them by the stemming operation.

With the tubing thus maintained in a position so that it extends as far into the hole as the top of the ammonium nitrate bed, the hole is then stemmed around the tubing with earth or other tamping materials 18. It can thus be seen that during the tamping operations, there is no sensitive explosive composition in the drilled hole, only ammonium nitrate and kerosene being present. As an alternative step, the hole may be stemmed after the ammonium nitrate and tube are inserted, but before the kerosene is introduced through the tube. As a further modification of my method, the ammonium nitrate and some, or all, of the kerosene to be used may be mixed outside the blast hole and lowered as a composite mixture into the hole.

It will be advantageous in the application of my

method, when there is water or dampness, to dispose the materials in a waterproof "bag" 20 as seen in Fig. 2 preferably made of polyethylene or other similar plastic materials, with said bag preferably being as long as, or longer than, the hole is deep. The bag has a lower closed end and a diameter, when expanded, greater than the diameter of the hole 25 so that when the bag is lowered into the hole, usually in a collapsed form, and constituents of the explosive are introduced into the bag, they will not rupture it. The bag, therefore, serves as a liner and permits the explosive to fit closely against the wall and bottom of the hole. In that way, the explosive is rendered completely waterproofed and also the liquid constituents aren't lost through crevices, etc. Primacord 29, exemplifying the detonating type as contrasted with an ignition type of detonator, may be fastened along the vertical wall either on the inside or the outside of the bag before it is lowered into the hole. The tube 27 which serves as a conduit for the kerosene may be lowered to a point adjacent the top level of the ammonium nitrate 26 inside the bag 20, and the upper end 20A of the bag can then be collapsed around it and the stemming material 28 may then be tamped into the hole around the tube and the upper end of the bag. I may use two tubes as seen in Fig. 3, permitting one 37A to serve as an air vent as the liquid constituents are introduced through the other tube 37, said tubes being lowered to adjacent the top level of the ammonium nitrate 36 inside the bag 30, the upper end 30A of the bag being collapsed around the tubes and the stemming material 38 tamped into the hole 35 around the tubes and upper end of the bag as in the modification according to Fig. 2.

With the tubing in place and the stemming of the hole completed, the Primacord 19 (Fig. 1), 29 (Fig. 2), or 39 (Fig. 3) or other similar suitable detonator, is connected with wires to the electrical switch. Nitrogen tetroxide is then run through the tubing and it descends to the bottom of the hole at which point it goes into solution with the kerosene to make an absolutely uniform solution of both liquids throughout the mass of ammonium nitrate and produces a compact explosive column. Such complete intermixing of the liquid constituents, and thereby of all components of the explosive mixture, is due to the fact that the heavier nitrogen tetroxide flows down through the lighter kerosene already surrounding the ammonium nitrate to produce, in effect, a solid column of explosive material, any void between the solid components being occupied by the liquid. If desired, the tubing may be removed from the hole before blasting.

As was earlier stated, it is a particular advantage of my method that the liquid components are added in order of their increasing densities so that the heavier will naturally intermix with the lighter. In this regard, it should also be kept in mind that the liquid having the lesser stability (the nitrogen tetroxide, for example) may be added lastly so as to minimize the losses due to volatility. In the exemplified application, although the kerosene and nitrogen tetroxide are known to mix thoroughly where the kerosene is introduced first and the heavier nitrogen tetroxide allowed to flow in subsequently, it is also within the contemplation of my method that, with the ammonium nitrate in place in the hole, a Y-connection 47B as seen in Fig. 4 may be made at the upper end of the tube 47 extending out of the hole 45 through which the nitrogen tetroxide via line 47C and kerosene via line 47D from separate containers may be allowed to run simultaneously so as to mix as they enter the blast hole. I may also meter the simultaneously introduced liquids in order to properly proportion them, since the amounts are not identical. Alternatively, the kerosene may be poured from its container into a receptacle, joined through a small hole in the bottom to the upper end of the tube, and mixed therein with nitrogen tetroxide added from its separate container.

The hole connecting the receptacle to the tube can be either kept closed until the two substances are mixed, or it can be left open when the kerosene is poured in because only a small amount of kerosene will run out before the mixture is complete. In this arrangement the opening from the kerosene container should be relatively small and that from the nitrogen tetroxide container relatively large.

Field testing of the method of introducing the several components into a blasting hole has shown that excellent control of one or more blasting operations being conducted in an area can be achieved. The nitrogen tetroxide can be run into the kerosene in the blast hole or in a container directly from a truck tank, but there are advantages in putting it in an individual container at each hole. The nitrogen tetroxide is prevented from running out of its container either by a valve or by a tube being looped and elevated above the liquid level. Then either the valve or loop can be manipulated by hand, or a distant control, to let the nitrogen tetroxide flow into the blast hole from one or a group of barrels.

The advantages of putting the nitrogen tetroxide in a separate container at each blast hole is that all of the nitrogen tetroxide containers can then be opened simultaneously or at approximately the same time and all holes, therefore, charged at the same time. Secondly, it is an additional safety precaution as no one need be near the blast hole while it is being charged.

It may be seen from the foregoing description that by the method of my invention, a composite explosive can be safely positioned at the bottom of a blasting hole in such a way that all components of the explosive are in intimate and complete admixture. Accordingly, what I claim as my invention is:

1. A method of positioning in a blast hole a composite explosive containing solid and liquid components, the liquid components comprising one which is denser and more unstable than another, which method comprises introducing the solid components in particulate form, introducing a tube into the hole so that its lower end is adjacent the top of the solid component, introducing the liquid components to the hole through said tube in the order of both their ascending densities and ascending instabilities.

2. The method of claim 1 wherein the hole is stemmed after the introduction of the tube but before the liquid components are introduced.

3. The method of claim 1 wherein the hole is stemmed after introduction of the tube and prior to the introduction of the less stable liquid components.

4. A method of positioning in a blast hole a composite explosive containing solid and liquid components the liquid components comprising one which is more unstable than another, which method comprises disposing in the blast hole and extending upwardly from the bottom thereof a flexible liner having its lower end closed and having a diameter, when expanded, greater than the diameter of said hole at the latter's lower end, and introducing into said liner in the hole the solid and liquid components to cause said liner to expand into complete contact with the adjoining bottom and side walls of the hole to form a solid column of explosive, the solid component being introduced first, and the more unstable one of the liquid components being introduced last.

5. The method of claim 4 wherein the liner is extended from the bottom of the blast hole to a position adjacent the upper end of the blast hole.

6. The method of claim 4 wherein the solid component is introduced in particulate form and at least a portion of the more stable liquid components is introduced into the liner in the hole mixed with the less stable liquid component.

7. A method of positioning in a blast hole a composite explosive containing solid and liquid components,

the solid component comprising ammonium nitrate in particulate form and said liquid components comprising a liquid hydrocarbon and nitrogen tetroxide, which method comprises disposing in the blast hole and extending upwardly from the bottom thereof a flexible liner having its lower end closed and having a diameter, when expanded, greater than the diameter of said hole, and introducing into said liner in the hole the ammonium nitrate, liquid hydrocarbon and nitrogen tetroxide to cause said liner to expand into complete contact with the adjoining bottom and side walls of the hole to form a solid column of explosive, the ammonium nitrate being introduced first and the nitrogen tetroxide last.

8. The method of claim 7 wherein the ammonium nitrate in particulate form is first poured into the liner in the blast hole after which a tube is inserted into the hole above the ammonium nitrate and the liquid components are introduced to the liner through said tube.

9. The method of claim 8 wherein the blast hole is stemmed after the introduction of the tube but prior to the introduction of the liquid components.

10. The method of claim 8 wherein the blast hole is stemmed after the introduction of the tube and the liquid hydrocarbon but prior to the introduction of the nitrogen tetroxide.

11. The method of claim 7 wherein the liquid components are both introduced into the liner in the hole at the same time and are mixed while being introduced.

12. A method of positioning in a blast hole a composite explosive containing a solid component comprising ammonium nitrate, and liquid components comprising kerosene and nitrogen tetroxide, which method comprises disposing in the blast hole and extending upwardly from the bottom thereof a flexible liner having its lower end closed and having a diameter, when expanded, greater than the diameter of said hole at the latter's lower end, introducing into said liner in the hole the solid component, then introducing into said liner at least one tube, said tube having its lower end above the solid component, introducing into the liner by said one tube the kerosene, collapsing the upper end of the liner around said tube and disposing stemming material around the liner and tube, and then introducing through said one tube the nitrogen tetroxide.

13. A method of positioning in a blast hole a composite explosive containing solid and liquid components which comprises disposing in the blast hole and extending upwardly from the bottom thereof a flexible liner having its lower end closed and having a diameter, when expanded, greater than the diameter of said hole at the latter's lower end, a detonating fuse having been secured to the vertical wall of the liner before introduction of the liner into the hole, and first introducing into said liner in the hole the solid and then inserting the liquid components through a tube to cause said liner to expand into complete contact with the adjoining bottom and side walls of the hole to form a solid column of explosive, said tube being inserted to adjacent the top of the solid component, the upper end of the liner being collapsed thereabout and stemming material inserted over and around said collapsed upper end of the liner and tube before the insertion of the liquid component through the tube.

14. A method of positioning in a blast hole a composite explosive containing solid and liquid components which method comprises disposing in the blast hole and extending upwardly from the bottom thereof a flexible liner having its lower end closed and having a diameter, when expanded, greater than the diameter of said hole at the latter's lower end, introducing into said liner in the hole the solid component, then introducing into said liner at least one tube, said tube having its lower end adjacent the top of the solid component, introducing into the liner by said one tube the more stable liquid component, collapsing the upper end of the liner around

said tube and disposing stemming material around the liner and tube, and then introducing through said one tube the more unstable liquid component, said solid and liquid components causing said liner to expand into complete contact with the adjoining bottom and side walls of the hole to form a solid column of explosive.

15. A method of positioning in a blast hole a composite explosive containing solid and liquid components which method comprises introducing the solid component in particulate form to form a column which assumes the shape of the hole, introducing a tube into the hole so that its lower end is adjacent the top of the column of solid component, then stemming the hole, and thereafter introducing the liquid component to the hole through said tube to mix with and substantially fill the voids between said particles of solid component.

16. A method of positioning in a blast hole a composite explosive containing solid and liquid components which method comprises disposing in the hole and extending upwardly from the bottom thereof a flexible liner having its lower end closed and having a diameter expandable to a diameter greater than the diameter of said hole at the latter's lower end, introducing into said liner the solid component in particulate form to cause said liner to expand into complete contact with the adjoining bottom and side walls of the hole to form a column of said solid component which will have the shape of the hole, then introducing into said hole at least one tube to adjacent the top of said column of solid component, collapsing the upper end of the liner about said tube and against the top of said column, disposing stemming material about the tube and collapsed liner, and introducing the liquid component through said tube to mix with and substantially fill the voids between said particles of solid component.

17. A method according to claim 16 wherein a vent tube is additionally introduced to said hole and the upper end of the liner is likewise collapsed thereabout.

18. A method according to claim 16 wherein the liquid components comprise a more stable and a less stable liquid material and at least a portion of the more stable liquid material is mixed with the solid component before its insertion into the liner, and the less stable liquid material is introduced through the tube last.

19. In a blasting operation, the process which comprises charging a hole in a formation to be blasted with ammonium nitrate in particulate form and mixed with combustible material, the charge being surrounded by expandable means of polyethylene material which permits the charge to fit closely against the bottom and walls of the hole while completely protected from contact with water through said bottom and walls, causing the charge to compactly fill the hole to a desired level while so protected by the polyethylene material and fitting closely against the bottom and walls of the hole, stemming the charge and subsequently detonating said charge.

20. In a blasting operation, the steps comprising disposing in a hole in the formation to be blasted a flexible waterproof liner of polyethylene material having its lower end closed and having a diameter expandable to a diameter greater than the diameter of said hole at the latter's end, charging said liner with a mixture of ammonium nitrate in particulate form and combustible material to compactly fill the same to a desired level, the liner of polyethylene material yielding so that said mixture fits closely against the bottom and walls of the hole while being protected against water present in the formation to be blasted, stemming the charge and subsequently detonating the charge.

21. In a blasting operation, the process which comprises charging a hole, in a formation to be blasted, with a free flowing explosive, the charge being surrounded by expandable means of polyethylene material which permits the charge to fit closely against the bottom and walls of the hole while completely protected from con-

7

tact with water through said bottom and walls, and causing the charge to compactly fill the hole to a desired level while so protected by the polyethylene material and to fit closely against the bottom and walls of the hole.

22. In a blasting operation, the steps comprising disposing in a hole in the formation to be blasted an elongated collapsed flexible waterproof liner of plastic material having its lower end closed and having a diameter expandable to a diameter greater than the diameter of said hole, and charging said liner with free flowing explosive material to compactly fill the same to a desired level, the liner being so expanded that the resultant com-

8

pact column of explosive fits closely against the walls and bottom of the hole while being protected against water present in the formation to be blasted.

5

References Cited in the file of this patent

UNITED STATES PATENTS

371,298	Bourne	Oct. 11, 1887
1,565,766	Weber	Dec. 15, 1925

10

FOREIGN PATENTS

44,422	Germany	Feb. 12, 1888
8,607	Great Britain	of 1915