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METHOD OF CHARGING WATER-FILLED BLAST HOLES WITH AMMONIUM NITRATE AND PRIMER CARTRIDGE USED IN SAME

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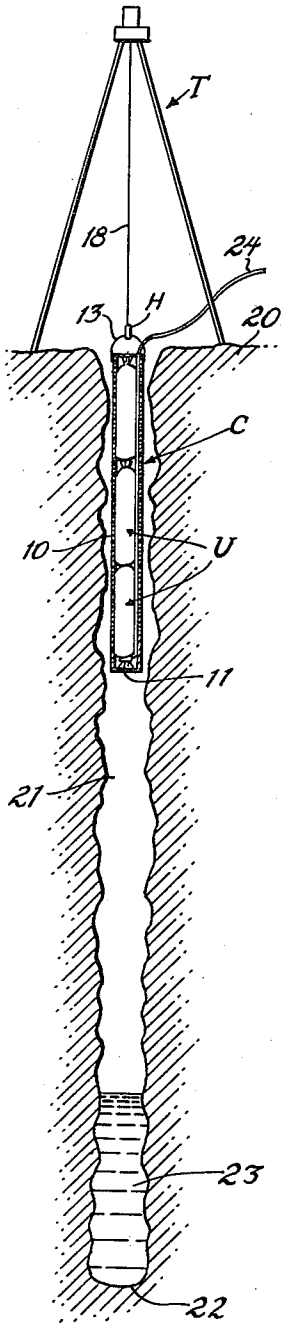


Fig. 1.

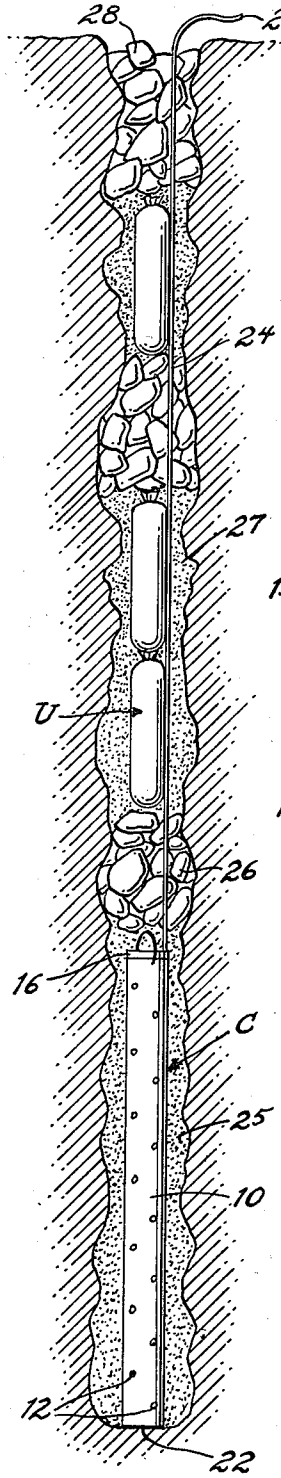


Fig. 2.

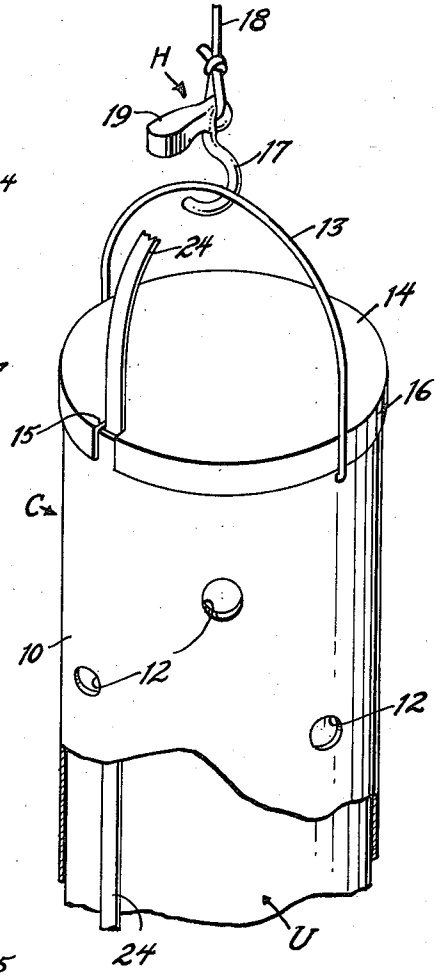


Fig. 3.

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METHOD OF CHARGING WATER-FILLED BLAST HOLES WITH AMMONIUM NITRATE AND PRIMER CARTRIDGE USED IN SAME

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6 Claims. (Cl. 86—20)

The present invention relates to the loading of flame pierced blast holes with an explosive charge and is concerned primarily with the loading of such a blast hole with an explosive charge comprising prilled ammonium nitrate and a primer cartridge therefor of a liquid oxygen explosive.

At the present time, mining operations of the strip or open type are extensively carried out on taconite iron ore. Such operations involve the formation of blast holes which are loaded with an explosive charge. During recent years the technique of forming so-called flame pierced blast holes has been developed. This technique involves the use of liquid oxygen in large quantities and for this reason, liquid oxygen is a material that is cheaply available on the iron range.

It has been found as a practical matter that it is utterly impossible to achieve anything approaching a regular or uniform diameter blast hole in taconite due to the constantly changing formation of the ore body. For this reason, a blast hole having an average diameter of 9" will vary in diameter from 6½" to 11". Moreover, the formation of such blast holes is an expensive operation with the cost being about three dollars and fifty cents ($3.50) a foot. Due to this high cost of forming the hole, it is extremely important that all the volume of the hole be usefully employed by completely filling it with the explosive charge.

Another factor of extreme importance entering into the claimed invention is the fact that the bottom of these blast holes which are formed in taconite iron ore are ordinarily water-filled up to a level of about 3 feet. However, the water ordinarily will not rise an appreciable distance above this level when the hole is filled due to cracks, crevices and fissures in the ore body.

Prior to the advent of the present invention, it has been the practice to load these flame pierced blast holes, the bottoms of which are water-filled, with an explosive charge comprising a combination of dynamite and TNT pellets. The dynamite costs about eighteen cents (18¢) a pound and the TNT pellets about twenty-two cents (22¢) a pound. The dynamite is loaded in cans of 5" diameter which will clear the narrowest portions of the hole, and these cans are lowered down into the bottom. The TNT pellets, which are water-proofed, are then deposited about the cans to completely fill the voids thereabout. With the dynamite and TNT pellets each constituting about 50% of the total charge, it is evident that the average cost of such an explosive charge is about twenty cents (20¢) a pound.

The present invention is founded on three main factors. These are:

(1) the proven acceptability of a liquid oxygen explosive as a detonator or primer;

(2) the cheap availability of liquid oxygen on the iron range; and

(3) there is now or about to be available to the public prilled ammonium nitrate which has been treated to render it water-proof. Thus, water-proofed prills of

ammonium nitrate are about to become available to the purchasing public for use as an explosive.

With the foregoing conditions in mind, the present invention has in view as its foremost objective the provision of a method of loading a water-filled, flame pierced blast hole with an explosive charge comprising ammonium nitrate and a primer cartridge of liquid oxygen explosive. Ordinary prilled or granulated ammonium nitrate will cost about three (3¢) or four cents (4¢) a pound. The cost of water-proofed prilled ammonium nitrate may be somewhat higher, but when it is considered that the cost of liquid oxygen explosive on the iron range is about eight cents (8¢) a pound, it is evident that the average cost of the total explosive charge may be held down to under seven and one-half cents (7½¢) a pound.

Still another object of this invention is to provide a method of the character aforesaid in which the liquid oxygen primer cartridge constitutes about one-third of the total explosive charge with the remaining two-thirds being represented by prilled ammonium nitrate.

A typical liquid oxygen explosive comprises a cylindrical casing that is filled with carbon in the form of lamp black. The casing is perforated and immediately before use is immersed in liquid oxygen so that the lamp black picks up or acquires about three or four times its own weight of the liquid oxygen. This explosive must be used within one hour after dipping due to the escape of the oxygen as it evaporates.

When a conventional liquid oxygen cartridge of the type aforesaid is immersed in water, the heat of the water causes such a rapid evaporation as to reduce this one hour time period above mentioned to twenty minutes. For this reason, up to the present time it has been considered impractical, if not impossible, to employ liquid oxygen explosives in conjunction with water-filled blast holes.

With this condition in mind, a further important object is to provide a method of the character aforesaid which adequately accommodates the presence of water in the blast hole and yet maintains unimpaired this one hour period before which the liquid oxygen explosive deteriorates to the extent that it is unusable.

More in detail, the invention has as an object the provision of a method which involves the use of a cylindrical container for receiving liquid oxygen cartridges and which container is so constructed and arranged as to keep the liquid oxygen explosive free of contact with the water.

In carrying out this idea, paper tubing, light walled (thin) aluminum tubing, or galvanized tin tubing is employed as a container. This container has a diameter somewhat narrower than the minimum diameter of the blast holes so that it may be readily lowered thereinto and has a length sufficient to accommodate a required number of liquid oxygen explosive cartridges. The latter ordinarily are 5" in diameter and have a length of about 20". Thus, with a minimum diameter of 6½" in the blast hole it is evident that the tubular container can readily accommodate the minimum diameter of the blast hole and that of the liquid oxygen explosive cartridges.

In carrying out the method, the container with its top open is first suspended from a tripod over the blast hole and then lowered thereinto until the open top thereof is substantially flush with the ground surface. A liquid oxygen cartridge having one end of a primacord secured thereto is then deposited in the container at the bottom thereof. A required number of liquid oxygen cartridges are then placed over the one on the bottom whereupon a cap is applied to close the open top of the container, provision being made for the primacord to pass therethrough. This cap serves two important functions. In the first instance, it prevents water from flowing down into the container. In the second instance, it causes a pressure from evaporating liquid oxygen to be built-up within the con-

tainer and this pressure in turn prevents water from entering the container through vents formed therein. Without this pressure it is believed that water would enter the container to shorten the life of the liquid oxygen explosive.

After the container has been filled and capped, it is lowered into the bottom of the flame pierced blast hole. Water-proofed prilled ammonium nitrate is then poured in to completely fill the voids in the blast hole about this container. This water-proofed prilled ammonium nitrate is continued up to a level of about 4" over the top of the container, whereupon the hole is stemmed to a desired height. It is common practice in this art to deck-load these blast holes, which means that the hole is charged at different levels with the primer cartridge of liquid oxygen explosive and prilled or granulated ammonium nitrate. For those stages above the bottom which are free of water it is unnecessary to utilize a container and the water-proofed ammonium nitrate prilles. For these stages, conventional liquid oxygen cartridges and ordinary prilled or granulated ammonium nitrate may be employed.

The hole is finally stemmed at the top and when the primer cartridges are detonated by the primacord the low sensitive ammonium nitrate is in turn detonated and during this action the ammonium nitrate will be overdriven due to the fact that all of the ammonium nitrate is in such close proximity to the primer charge as to be overdriven thereby. This principle of overdriving the ammonium nitrate is fully explained in the copending application of John Frank Barco and Dean Elliott Albon, Serial Number 642,215, filed February 25, 1957, and entitled "Primer for Ammonium Nitrate and Method of Using Same."

Another highly important object of this invention is to provide a primer cartridge intended for use in conjunction with water-filled flame pierced blast holes and water-proofed prilled ammonium nitrate, and which primer cartridge consists essentially of a tubular container filled with liquid oxygen explosive units and suitably capped.

Various other more detailed objects and advantages of the invention such as arise in connection with carrying out the above noted ideas in a practical embodiment will in part become apparent and in part be hereinafter stated as the description of the invention proceeds.

The invention therefore comprises a method of loading a water-filled flame pierced blast hole of irregular diameter with an explosive charge comprising a primer cartridge of liquid oxygen explosive and water-proofed prilled ammonium nitrate and novel features of the primer cartridge employed in such a method.

For a full and more complete understanding of the invention reference may be had to the following description and accompanying drawing wherein:

Figure 1 is a side view taken as a vertical section through a flame pierced blast hole and depicting the initial step in the method of this invention;

Figure 2 is a view similar to Figure 1, showing the blast hole as finally loaded with the explosive charge; and

Figure 3 is a detailed perspective taken on an enlarged scale of the upper end portion of the primer cartridge.

Referring now to the drawing and first more particularly to Figure 3, the primer cartridge of this invention will be described. This cartridge is referred to in its entirety by the reference character C and comprises a tubular container **10** having an inside diameter somewhat in excess of 5" and an outside diameter somewhat less than 6½". The tubular container **10** is closed at the bottom, as indicated at **11** in Figure 1, and is open at the top. It may be made of paper tubing, thin aluminum or galvanized tin. The cylindrical wall is provided with a plurality of air vents such as represented at **12**. Secured to this cylindrical wall **10** in a well-known manner and extending over the open top is a bail **13** that is employed for suspension purposes.

A cap for the open top of the cylindrical container **10** is shown at **14** and is provided with a cut-out or recess **15** at one side, for a purpose to be later described. The cap **14** includes a cylindrical skirt **16** which snugly receives the upper end of the tubing **10**.

A counterbalanced hook intended for use in lowering the container C into a blast hole is referred to in its entirety by the reference character H. This hook H comprises a bill **17** that is secured to a line **18** and which is counterbalanced by weight **19**. It is evident that when a filled container C reaches the bottom of a blast hole and the weight is taken from the hook H, the counterbalance **19** will free the bill **17** from the bail **13**.

A liquid oxygen cartridge unit is referred to in its entirety by the reference character U. Each of the units U is about 5" in diameter and 20" long. Ordinarily each of these cartridge units comprises a perforated cardboard or paper casing that is filled with carbon black and is immersed in liquid oxygen immediately prior to the loading operation.

Referring now more particularly to Figure 1, a geological formation is represented at **20**. This geological formation will ordinarily be taconite iron ore. An irregular blast hole **21** is formed in the taconite **20** by a flame piercing operation which, as mentioned above, involves the use of liquid oxygen. Because of the fact that liquid oxygen is employed in the formation of the blast hole **21**, this same liquid oxygen is cheaply available at the scene of the mining operation.

The blast hole **21** will have a diameter ranging from a minimum of 6½" to a maximum of about 11" with the average diameter being in the nature of 9". The bottom of the blast hole is shown at **22**, and water represented at **23** is present in the blast hole **21** for a height of about three feet above the bottom **22**.

In practicing the method of this invention, a tripod T is first erected in position over the open top of the blast hole **21**. A container of a primer cartridge is then suspended from the line **18** by the hook H and bail **13** and lowered into position until the open top of the container is substantially flush with the ground surface. One end of a primacord **24** is then tied to a liquid oxygen cartridge unit U and the latter lowered into the container **10** until it reaches the bottom thereof. The primacord **24** will assume a position running up one side of the cylindrical wall **10**. Additional liquid oxygen cartridge units U are then deposited into the container **10** until the latter has received the required number of such units. The cap **14** is then placed in position with the cut-out **15** accommodating the primacord **24**. At this point, this recess **15** may be closed by an appropriate quick-sealing compound that is placed about the primacord so as to render the cap **14** and its joinder to the container **10** completely water-proof.

The primer cartridge C is now lowered down into the blast hole **21** until it reaches the bottom thereof. This, of course, means that it becomes immersed in the water **23**. The latter will rise but little due to the fact that the ore formation **20** has cracks and crevices therein which accommodate the rising water.

It is evident that with the primer cartridge C in the position in the bottom of the blast hole **21**, oxygen evaporating from the cartridge units U will build up a pressure due to the confinement caused by the cap **14**. This pressure will effectively prevent any water from entering the interior of the container though the vents **12**.

Water-proofed prilles of ammonium nitrate such as represented at **25**, are now poured in about the primer cartridge C to completely fill the voids and spaces thereabout. This operation is continued until the water-proofed prilles of ammonium nitrate reach a level of about 4" over the top of the container. At this point it might be well to mention the fact that such water-proofed prilles of ammonium nitrate are about to be made available to the public by the Monsanto Chemi-

cal Company which has been devoting considerable research to the problem of water-proofing ammonium nitrate so that its use as an explosive will not be impaired by the presence of water.

In loading blast holes of the type with which this invention is concerned, it is common practice to deck-load the blast holes. Thus, after the bottom portion of the blast hole has been filled with the primer cartridge C and water-proofed ammonium nitrate prilles **25**, stemming such as represented at **26** is filled into the hole. Such stemming ordinarily will consist of rock cuttings.

An additional stage of the deck-loading is then deposited into the hole and in this stage conventional cartridge units U may be employed in conjunction with ordinary prilled or granulated ammonium nitrate, such as represented at **27**. Thus, with these upper stages it is unnecessary to use a container **10** or the water-proofed prilles of ammonium nitrate. This loading of stages is repeated until the top of the hole is finally stemmed, as represented at **28**. The primacord **24** is of course continued up through the various levels and is available for detonating purposes.

With the dimensions given below, it is evident that it is utterly impossible for any of the ammonium nitrate to be removed from the primer cartridge a distance in excess of 4". Thus, when the primer cartridge is detonated, the ammonium nitrate will be overdriven at a rate of detonation at least approaching that of the liquid oxygen explosive.

While a preferred specific embodiment of the invention is hereinbefore set forth, it is to be clearly understood that the invention is not to be limited to the exact steps, materials and dimensions herein described because various modifications of these details may be provided in putting the invention into practice within the purview of the appended claims.

What is claimed is:

1. In the loading of an irregular water-filled blast hole with an explosive charge comprising prilled ammonium nitrate and a primer cartridge of liquid oxygen explosive, the method comprising the steps of: depositing a cartridge unit of liquid oxygen explosive in a tubular container, capping the container, lowering the container into the water-filled bottom portion of the blast hole, and depositing waterproofed prilles of ammonium nitrate in said hole about said container to completely fill the voids about said container.

2. In the loading of an irregular water-filled blast hole with an explosive charge comprising prilled ammonium nitrate and a primer cartridge of liquid oxygen explosive, the method comprising the steps of: attaching one end of a primacord to a cartridge unit of liquid oxygen explosive, depositing said unit in a tubular container, depositing additional cartridge units of liquid oxygen explosive in said container, capping the container, lowering the container into the water-filled bottom portion of the blast hole, and depositing waterproofed prilles of ammonium nitrate in said hole about said container to completely fill the voids about said container.

3. In the deck loading of an irregular water-filled blast hole with an explosive charge comprising prilled ammonium nitrate and a primer cartridge of liquid oxygen explosive, the method comprising the steps of: depositing a cartridge unit of liquid oxygen explosive in a tubular container, capping the container, lowering the container into the water-filled bottom portion of the blast hole, depositing waterproofed prilles of ammonium nitrate in said hole about said container to completely fill the voids about said container, stemming said hole above said container and waterproofed prilled ammonium nitrate, and loading a second stage of said blast hole by depositing a cartridge unit of liquid oxygen explosive therein and filling the space thereabout with prilled ammonium nitrate.

4. In the deck loading of an irregular water-filled blast hole with an explosive charge comprising prilled ammonium nitrate and a primer cartridge of liquid oxygen explosive, the method comprising the steps of: attaching one end of a primacord to a cartridge unit of liquid oxygen explosive, depositing said unit in a tubular container, depositing additional cartridge units of liquid oxygen explosive in said container, capping the container, lowering the container into the water-filled bottom portion of the blast hole, depositing waterproofed prilles of ammonium nitrate in said hole about said container to completely fill the voids about said container, stemming said hole above said container and waterproofed prilled ammonium nitrate, and loading a second stage of said blast hole by depositing a cartridge unit of liquid oxygen explosive therein and filling the space thereabout with prilled ammonium nitrate.

5. In the loading of an irregeular water-filled blast hole with an explosive charge comprising prilled ammonium nitrate and a primer cartridge of liquid oxygen explosive, the method comprising the steps of: lowering an open top tubular container into a blast hole until the open top is flush with the ground surface, depositing a cartridge unit of liquid oxygen explosive into said container, capping the container, lowering the capped container into the bottom of a water-filled blast hole, and depositing waterproofed prilles of ammonium nitrate about said container to fill the voids thereabout.

6. In the loading of an irregular water-filled blast hole with an explosive charge comprising prilled ammonium nitrate and a primer cartridge of liquid oxygen explosive, the method comprising the steps of: lowering an open top tubular container into a blast hole until the open top is flush with the ground surface, attaching one end of a primacord to a cartridge unit of liquid oxygen explosive, depositing said unit in said container, depositing additional cartridge units of liquid oxygen explosive in said container, capping said container, lowering the capped container into the bottom of a water-filled blast hole, and depositing waterproofed prilles of ammonium nitrate about said container to fill the voids thereabout.

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