

Title**METHOD AND APPARATUS FOR CHARGING A HOLE**Field of the Invention

- 5 The present invention relates to a method of charging a hole, particularly though not exclusively, for the purposes of the fracturing or excavating hard material such as rock and concrete.

Background of the Invention

- 10 The excavating or fracturing of hard material is a pivotal activity in the mining and construction industries. One known way of achieving this is the drill and blast method. This involves drilling a hole in the hard material and charging the hole with a quantity of energetic material and usually some type of stemming. Not surprising, the way in which a hole is charged has a substantial effect on the efficiency and result of the drill and blast
15 method.

- A typical procedure for charging a hole is simply to insert an energetic material together with an initiator into the hole then fill the hole either completely or to a predetermined depth with some type of stemming eg sand, gel or a stemming bar and set off the initiator
20 which in turn initiates the energetic material. At times, particularly if a stemming bar is used, a heavy vehicle or machine (eg a jumbo) or some other mass is used to hold the stemming bar in place so that it does not turn into a projectile upon initiation of the energetic material. This requires that the vehicle or machine holding the stemming bar in place is able to withstand the transmission of substantial forces without itself becoming
25 damaged. Mine managers and construction supervisors are, not surprisingly, reluctant to use there machinery as shock absorbers in this manner. Damage may also be incurred to machinery by fly rock generated by fragmentation of the collar area of the hole.

- When involved in excavation or civil construction in built up areas safety is an absolute
30 requirement and authorities are unlikely to allow procedures that will lead to the creation of fly rock or other projectiles. One is free to use non explosive methods in such instances, however generally these are a more expensive option and often can reduce the

margin to the contractor to a level where it is no longer economic to tender for a particular job.

5 In the case of a particulate stemming, eg sand, drill cutting etc the ejection of the stemming from the free face of the hole is common place. This is evidence of a lack of efficiency in the charging process as a non industrial part of the blast energy is dissipated by imparting energy to the stemming to eject it from the hole.

Summary of the Invention

10 It is an object of the present invention to provide a method for charging a hole and a method of producing a charged hole that attempts to alleviate at least one of the problems in the above described prior art.

15 According to the present invention there is provided a method of charging a hole including the steps of:

- (a) inserting an energetic material and an initiator into the hole;
- (b) filling the hole to a predetermined level with an energy absorbing stemming
20 material;
- (c) inserting a plug into the hole to rest on the stemming material the plug being provided with means for facilitating the coupling of the initiator with an initiation source; and
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- (d) mechanically holding the plug in the hole to prevent substantial movement of said plug away from the bottom of the hole, whereby, in use, on coupling of said initiator to said initiation source via said plug, said energetic material is initiated providing a rapid increase in gas pressure near the bottom of the hole and said
30 stemming material acts to absorb pressure generated by said gas acting away from the bottom of the hole to substantially isolate said plug from said gas pressure and concentrating the action of said gas pressure on the bottom of the hole.



Preferably step (b) comprises filling the hole to a level substantially adjacent or below the collar area of the hole.

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Preferably step (c) above, includes providing a plug with an aperture, recess or slot through which a lead can pass from said initiator to said initiation source to facilitate coupling therebetween; and, threading said lead through said aperture or recess when inserting the plug into said hole.

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In an alternate embodiment, step (c) above, includes providing said plug with a transducer for facilitating wireless electromagnetic coupling of said initiator to said initiation source.

Preferably step (d) comprises bearing or placing a mass on an upper end of said plug.

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Alternately or additionally step (d) includes wedging the plug in the hole.

According to another aspect of the invention there is provided a method of producing a charged hole in a hard material to be fragmented, said method including the steps of:

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(a) providing a drill for drilling a hole in said hard material;

(b) inserting an energetic material and an initiator into said hole;

25 (c) stemming the hole up to a predetermined level with an energy absorbing stemming material;

(d) inserting a plug into the hole to rest on said stemming, the plug being provided with means for facilitating the coupling of the initiator with an initiation source;
30 and,



- 5 (e) mechanically holding said plug in the hole to prevent substantial movement of said plug away from the bottom of said hole, whereby, in use, on coupling of said initiator to said source by said plug, said energetic material is initiated providing a rapid increasing gas pressure near the bottom of the hole and said stemming acts to absorb gas pressure acting away from the bottom of the hole thereby substantially isolating said plug from said gas pressure.

10 Preferably step (e) comprises bearing at least a portion of the weight of said drill on an upper end of said plug.

10 According to another aspect of the invention there is provided a method of charging a hole including the steps of:

- 15 (a) inserting an energetic material and an initiator into the hole;
- (b) filling the hole to a predetermined level with an energy absorbing stemming material;
- 20 (c) providing a multicomponent plug and inserting the plug into the hole to rest on the stemming material, the plug being provided with a means for facilitating the coupling of the initiator with an initiation source;
- (d) moving one or more of the components of the plug relative to each other to create a wedging action to mechanically hold the plug in the hole.

25 According to a further aspect of the invention there is provided a method of charging a hole including the steps of:

- 30 (a) inserting an energetic material and an initiator into the hole;
- (b) filling the hole to a predetermined level with an energy absorbing stemming material;



- (c) mechanically retaining the stemming material in the hole by providing a plug and inserting the plug into the hole and mechanically holding the plug in the hole.
- 5 Preferably the method further includes providing the plug with means for facilitating the coupling of the initiator with an initiation source.

According to another aspect of the present invention there is provided a stemming bar for stemming a hole in a hard material the hole having a charge of energetic material at the
10 bottom thereof, the stemming bar including a first opening at a first end, a second opening distant the first opening so that when the first end of the stemming bar is placed in a hole, the second opening is outside the hole, and a slot, passage or recess extending between the first and second openings through which an initiator means can be delivered for initiating or detonating the energetic material in the hole.

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Preferably the stemming bar is provided with means at its first end to facilitate attachment to a container bearing said energetic material, so that when the stemming bar is inserted into the hole, the energetic material is simultaneously placed in the hole.

- 20 Accordingly another aspect of the present invention there is provided a method charging a hole to effect the fracturing of hard material including the steps of:

drilling a hole in the hard material;

placing a quantity of energetic material in the hole;

- 25 providing a stemming bar formed with a slot, passage or recess having a first opening at a first end of the bar adapted for insertion into the hole and a second opening spaced from the first opening by a distance so that the second opening is external to the hole;

inserting the stemming bar with said first end first into the hole;

- 30 delivering initiator means through said second opening, down said slot, passage or recess and out said first opening and into operational contact with the energetic material so that the initiator means can initiate the energetic material to effect fracturing of the hard material.



Preferably the method further includes the step of mechanically holding or retaining the stemming bar in the hole.

- 5 Preferably the step of placing the energetic material in the hole includes supporting the energetic material at the first end of the stemming bar so that the energetic material is placed in the hole by insertion of the first end of the stemming bar into the hole.

- 10 Preferably the step of supporting the energetic material at the first end of the stemming bar includes providing a container for containing the energetic material and attaching the container to the first end of the stemming bar and in communication with said first opening.

- 15 In one embodiment, the container is attached to the stemming bar by means of mutual threaded engagement.

In alternate embodiments, the container is push fitted, or snap fitted to the first end of the stemming bar.

- 20 The initiator means is in any form that can be delivered through the slot, passage or recess in the stemming bar and can include for example a detonator, an electric match, a non electric igniter, a length of fuse cord; or a flame directed down the slot, passage or recess. In the event that the initiator means is a flame, the flame can be produced by a shotgun cartridge filled with appropriate pyrotechnic material or a theatrical shell or cap. The
25 energetic material can be in the form of an explosive or a propellant.

Brief Description of the Drawings

Embodiments of the present invention will now be described by way of example only with reference to the accompanying drawings in which:

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Figure 1 is a schematic representation of a charged hole produced in accordance with embodiments of the present method;

- Figure 2 is a schematic representation of a charged hole formed in accordance with the second embodiment of the invention;
- Figure 3 is a schematic representation of a charged hole formed in accordance with the third embodiment of the invention;
- Figure 4 is a schematic representation of a charged hole formed in accordance with the fourth embodiment of the invention;
- Figures 5-8 illustrate different embodiments of wedging plugs that can be used in the present methods;
- Figure 9 is a front view of a stemming bar adapted for use in embodiments of the method of charging a hole;
- Figure 10 is a view of section AA of Figure 10;
- Figure 11 is a cross sectional view of a second embodiment of the stemming bar and also illustrating an alternate method of charging a hole; and,
- Figure 12 is a sectional view of a further embodiment of the stemming bar and method of charging a hole.

Detailed Description of Preferred Embodiments

- The general methodology employed in embodiments of this invention is depicted in Figure 1. The figure illustrates a bench 10 of hard material such as rock in which a hole 12 has been drilled using a conventional drill rig. Once the hole 12 has been drilled, a cartridge or quantity of energetic material such as an explosive or propellant 14 is inserted into the hole and sits on or near the bottom of the hole 12. Located in operative association with the energetic material 14 is an initiator 18. The initiator 18 may be part of an integral package also containing the energetic material 14. Alternately, it may be a separate initiator that is inserted into the hole with the energetic material 14. The hole 12

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is then filled with stemming material 20 to a predetermined level L commensurate with the end of the collar area C of the hole 12. The stemming material 20 used is one that is capable of absorbing energy or shock waves rather than one that transmits the energy or shock waves. For example, the stemming will ideally be in the form of a loose or self
5 packed granular or particulate material such as sand, gravel, clay, crusher fines, or drill cuttings, or a liquid or colloidal suspension that has the property that its viscosity increases with increasing shear.

Once the stemming 20 has been inserted into the hole, a plug 22 is then inserted into the
10 hole. In the embodiment shown in Figure 1, the plug 22 is of a T shaped section having a central short bar 24 and a transversely extended cross bar 26. The length of the plug 22 or more particularly the bar 24 is equal to or greater than the depth of the hole 12 when filled with the stemming 20. That is, the bar 24 should be of a length to retain the stemming from a location at or below the collar area C of the hole 12.

15 The plug 22 is able to facilitate a coupling of the initiator 18 with an initiation source (not shown). In the embodiment shown in Figure 1, this is done by providing the plug 22 with a passage, slot or recess through which a lead 28 can pass to facilitate connecting the initiator 18 with the initiation source. Embodiments of such stemming bars are illustrated
20 in Figures 9-12 attached and described in greater detail below.

Finally, the upper end of the plug 22 protruding from the hole 12 is mechanically held down. In this embodiment, this is done by placing a mass, such as the bucket 30 of an excavator 32, on the end of the plug. However the same effect can be achieved by
25 placement of the drill rig used to initially drill the hole 12, or another mass such as a block of concrete or a sand bag.

When the initiator 18 is connected to the initiation source, it initiates the energetic material 14, which in turn explodes or combusts. When this occurs, there is a very rapid rise in gas
30 pressure near the bottom of the hole 16. The pressure acts in all directions including the upward direction and thus on a stemming 20. Gas pressure acting in this direction compacts or locks the stemming 20 together as the stemming 20 is prevented from being

blown out of the hole by the plug 22 and mass 30. As the plug 22 is of the length at least commensurate with the length of the collar area C of the hole 12, the likelihood of the collar area C being fragmented and energised to the extent of producing fly rock is remote. Further, by preventing the stemming 20 from being ejected from the hole 12, and as the
5 stemming 20 is able to be compacted and locked into place against the surface of the hole, a greater proportion of the blast energy and gas pressure, than otherwise would be the case, is able to act at the bottom of the hole 16. As such, the blast efficiency is improved. Accordingly either smaller charges can be used to excavate or fracture the same volume of
hard material or alternately, use of the same amount of energetic material as in the prior art
10 would lead to an increased volume of excavation or fracturing.

Figure 2 illustrates a minor variation in the equipment used to effect the current method. In this figure, like reference numbers are used to denote like features. The substantive differences between the embodiments of Figure 1 and Figure 2 are that the stemming 20 is
15 provided in a package 34 and that the plug 22 is a simple stemming bar that does not include the cross bar 26 as depicted in Figure 1. For different applications, the package 34 may be of different lengths and diameters and may contain different types of stemming 20. Also if desired or necessary, more than one stemming package 34 can be inserted into the hole 12. The performance of the method using the stemming package 34 and simple plug
20 22 is the same as described in relation to Figure 1. The plug 22 is again arranged of a length to ensure that it holds or retains the stemming at a level at or below the collar area C of the hole 12. In the method, the energetic material 14 and initiator 18 are initially inserted into the hole 12. The stemming package 34 is then inserted into the hole. Typically, the lead 28 will be disposed between the outside of the packaged stemming 34
25 and the surface of the hole 12. The lead 28 is then threaded through a passage or recess in the plug 22 and connected to a suitable initiation source. Any suitable available mass is then placed on the top of the plug 22 and the initiation source activated to cause initiation of the energetic material 14. The functioning of the packaged stemming 34, plug 22 and mass (not shown) is the same as that described in relation to Figure 1 above. The plug 22
30 could also be provided with a cross bar 26 or upper plate, grate or flange to increase the area on which the mass can bear.

In a further variation depicted in Figure 3, instead of having a lead 28 extending from the initiator 18 through the plug 22 to an initiation source, a transducer 36 is provided in the plug 22 for providing wireless electromagnetic/magnetic coupling of the initiator 18 to an initiator source (not shown). In order to achieve this coupling, a receiver 38 is coupled or associated with the initiator 18 to decode appropriate firing codes and/or extract operational power from signals transmitted by the transducer 36. To assist in the transmission of signals from the transducer 36 to the receiver 38, the stemming 20 may be formed of, or include, magnetically and/or electrically conductive particles. An appropriate transducer 36 and receiver 38 are described in International Application No PCT/AU98/00929. In this embodiment, the stemming 20 is again shown as loose, ie unpackaged stemming. However the stemming can also be packaged stemming 34 as in Figure 2 with the container or packaging per se formed of a magnetically and/or electrically conductive material or otherwise carrying or having embedded therein particles or wires etc having such properties. Because of the manner in which the plug 22 facilitates the coupling of the initiator 18 to an initiation source, there is no need to thread a lead through the plug 22 as in the methods described in relation to Figures 1 and 2. However, in all other respects, the method of charging the hole 12 is the same.

A further variation in the equipment capable of performing the method is illustrated in Figure 4. In this embodiment, the plug 22 is provided with electrical leads 40 and 42 connectable to an AC or DC ignition source. Lead 40 may be a ground or reference lead that is electrically coupled to the ground 10 either via the plug 22 itself or by the provision of an extension (not shown) that bears against the inside of the hole 12. The other lead 42 is a control lead that is electrically isolated from lead 40 to allow for the creation of a potential difference with lead 40. The initiator 18 is in this instance an electric initiator and has one terminal 44 arranged to be in electrical connection with the lead 40 say via grounding with the surface of the hole 12 and a second lead 46 that is arranged to be in electrical connection with the lead 42. This connection may occur via the packaged stemming 34. As with the previous embodiments, once the energetic material 14, initiator 18, stemming 20 and plug 22 are placed in the hole, the upper end of the plug 22 is mechanically held down. Leads 40 and 42 extending from the plug 22 can be connected to an electrical power source for providing an AC or DC current as required to cause

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activation of the initiator 18 and subsequent initiation of the energetic material 14. The gas dynamics within the hole 12 are the same as described in relation to the previous embodiment. The packaged stemming 34 is maintained in the hole by the mechanically held plug 22. As gas pressure increases, the stemming 20 compacts and substantially isolates the plug 22 and thus the mass or other mechanical means acting thereon from a substantive gas pressure so that there is insubstantial shock applied to the mass/means. Also, as the plug 22 is maintained within the hole 12 and has its lower end out or below the level of the collar area C there is little likelihood of the collar area C of the hole being blown away. Thus, the action of the mass, plug 22 and stemming 20/package stemming 34 is to concentrate the build up in gas pressure to the bottom of the hole 16. This maximises the efficiency of the process.

The above described embodiments relate to charging of the hole 12. However, methods in accordance with this invention can extend to the method of actually forming a charged hole which in substance is the same as in methods described above but with the additional initial step of first providing a drill and then drilling the hole 12. In this method, it may be most convenient to use the drill cuttings created when drilling the hole 12 to act as the stemming 20. Also, given that a drill is initially providing for drilling the hole 12 the drill may also itself be used as the mass applied to the top of the plug 22 to mechanically hold it in place.

Figures 5-8 illustrate alternate methods for mechanically retaining the stemming 20 in the hole by use of various types of expandable plugs.

In Figure 5, the plug 22 comprises tapered bars 22a and 22b that can be slid over each other to increase the overall diameter of the plug 22 when in the hole 12 in order to mechanically retain the plug 22 in the hole by a wedging action. The bar 22a is provided with a passage, slot or recess through which the lead 28 can pass to facilitate connecting the initiator 18 with an initiation source in a similar manner as depicted with reference to the embodiments shown in Figures 1 and 2.

In Figure 6, the plug 22 is composed of a tapered cone 22c and a complementarily tapered

upper wedge 22d. The cone 22c is placed in the hole 12 with its largest diameter end first and bears against the stemming 20. The wedge 22d is then placed over the cone 22c and pressure then applied to it to push it downward over the cone 22c so as to effectively wedge into the hole 12. In order to assist or facilitate the wedging action, the wedge 22d
5 can be provided with a plurality of longitudinal fingers or slits that can radially spread outwardly when pushed against the cone 22c. Further, upon initiation of the energetic material the build up in gas pressure acts to try to eject the stemming 20 from the hole 12. This in turn acts to tighten the core 22c/wedge 22d combination against the hole 12 thus further resisting ejection of the stemming 20. In this embodiment, both of the components
10 22c and 22d of the plug 22 are provided with collinear passages through which the lead 28 can pass.

Figure 8 illustrates a plug 22 comprising a cone 22e for seating inside a wedging base 24f. In essence, the plug 22 shown in Figure 8 is in the inverse of the plug 22 shown in Figure
15 6. In Figure 8, the base 24f sits on the stemming 20 and has a central tapered aperture for receiving the cone 22e. As the cone 22e is pushed further down into the base 22f the upper end of the base 22f expands radially outwardly to wedge against the surface of the hole 12. Collinear passages or slots are formed in the base 22f and cone 22e to allow for the passage of the lead 28.

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Figure 9 depicts perhaps the simplest form of plug 22 comprising a stemming bar 22g of a form substantially identical to that shown in Figure 2 together with a simple wedge 22h that is wedged or forced in between the stemming bar 22g and the side of the hole 12.

25 In each of the embodiments shown in Figures 5-8 further mechanical retention of the stemming 20 or stemming package 34 can be achieved by bearing a weight or mass on the end of the plug 22 in a manner similar to that depicted with reference to the embodiment shown in Figure 1.

30 By mechanically retaining the stemming material the effect of the stemming is enhanced while at the same time reducing noise and flyrock. The function of the stemming 20 is to direct the axial pressure force created by the initiation of the energetic material into radial

compression forces against the wall of the hole, thus leading to large friction force resisting ejection of the stemming from the hole and consequently longer retention of gas pressures at the bottom of the hole 12. Clearly, by mechanically retaining the stemming thus preventing its ejection from the hole, its effect and benefit is enhanced. Blasting efficiency is further enhanced by mechanically retaining a stemming at a location in the hole adjacent or below the collar area. This acts to isolate the collar area from the substantive pressure forces thereby reducing the likelihood of the collar area being blown away generating flyrock. As previously described, the mechanical retention of the stemming can be by way of an expandable plug that is inserted into the hole in an unexpanded condition and then expanded to bear against the sides of the wall. Pressure forces transmitted by the stemming 20 to the expandable plug act to further expand the plug outwardly increasing the mechanical retaining force on the stemming. It forms in effect an self tightening or locking system for retaining the stemming material. Alternately, mechanical retention can be achieved by inserting an unexpandable rod or plug into the hole and bearing a weight or mass on the plug. This can be achieved by use of equipment typically available on mine sites such as earth moving equipment, chains, sandbags, and the like. It is also of course possible to combine the use of both an expandable plug and an external weight or mass acting on the plug to mechanically retain the stemming material.

Figures 9 and 10 depict a stemming bar 22k that can be incorporated into several of the embodiments of the method described above. For example the stemming bar 22k or a stemming bar of like form can be used in the embodiments depicted in Figures 1, 2, 5 (replacing the tapered bar 22a) and Figure 8.

The stemming bar 22k is in the general form of a cylindrical bar of metal (such as steel) having a first opening 44 at a first end 46, being the end of the bar 22k that is inserted into the hole 12; and, a second opening 48 at a location at or near upper end 50 at a location so that when the first end 46 is inserted into the hole 12 the opening 48 is located outside of the hole 12. A slot 52 is cut or otherwise formed longitudinally along the stemming bar 22k running from the first opening 44 to the second opening 48. A plurality of pins 58 extend transversely across the slot 56. The pins 58 are roughly evenly spaced along the

length of the slot 56. The main purpose of the pins 58 is to form a guide to attempt to maintain an initiator or detonator cord within the confines of the bar 22k.

In an alternate form of the stemming bar 22l depicted in Figure 11 instead of the slot 56 extending along the outer surface of the stemming bar 22k, an internal passage 56a is provided. The passageway 56a runs between the first opening 44a at the bottom of the stemming bar 22l and second opening 48 located on the outer circumferential surface of the stemming bar 22l near upper end 50 of the stemming bar 22l. An initiator cord or lead 28 extends through the passageway 22l.

The form of the stemming bar depicted in Figures 10-11 leads to the provision of alternate methods of charging a hole. One such alternate method is shown in Figure 11. Here, the energetic material 14 is contained within a cartridge 60 that is coupled to end 46 of the stemming bar 22l. The coupling is by way of an interference fit with the end 46 of the stemming bar 22l being tapered so as to reduce in diameter in a direction toward the bottom of the hole 12. The method includes initially drilling a hole in hard material 10 such as a rock or boulder, pushing the cartridge 60 onto the end 46 of stemming bar 22l, inserting the stemming bar 22l into the hole 12 within 46 first and then feeding the initiator cord 28 through opening 48a down passageway 22l and out of opening 44a into the bottle/cartridge 60 into operational contact with the energetic material 14.

To prevent the stemming bar 22l from ejecting from the hole 12 upon detonation of the energetic material 14 it may be held in place by a massive object such as a bull dozer, bob cat, jumbo or other vehicle bearing against the end 50. A penetrating cone fracture (PCF) would typically be formed as shown by fracture line F in Figure 11 as a result of the initiation of the energetic material 14.

It is to be understood that the stemming bar 22k depicted in Figures 9 and 10 can of course be used in place of the stemming bar 22l in the embodiment shown in Figure 12.

A further embodiment is shown in Figure 12. In this embodiment, the container 60 holding energetic material 14 is not supported or otherwise directly coupled to the

stemming bar 22m. Rather, the container 60 is lowered into the hole 12 prior to insertion of the stemming bar 22m. The energetic material 14 is held in a bag which is flammable or readily melts upon contact with a flame. In the further variation from the embodiment shown in Figure 12 initiation is effected by way of a flame that passes through the passageway 56b rather than through a physical initiator such as a detonator, electric match, non electric match or fuse cord. The flame can be created by a shot gun cartridge 62 filled with a pyrotechnic material. The cartridge 62 is held within a chamber 64 located at upper end 50 of the stemming bar 22m, and is triggered in a conventional manner by use of a firing pin. Thus, in this embodiment, upon firing of the cartridge 62, a flame enters the passageway 56b through opening 48b and exits at the opposite end of the stemming bar 22m through opening 44b burning through the bag holding the energetic material 14 causing the energetic material to ignite or detonate. The embodiments depicted in Figures 12 and 13 are particularly well suited to small charge blasting. A substantial benefit of these embodiments is that the initiator is delivered to the energetic material 14 after the stemming bar 22 has been placed in the hole 12. Because the initiator 30 is placed in the hole 12 after the stemming bar 22, there is no risk of it being accidentally or prematurely set off by the insertion pressure of the stemming bar 22, or being damaged by the system in bar 22 so as to be non effective.

Now that embodiments of the invention have been described in detail it will be apparent to those skilled in the relevant arts that numerous modifications and variations may be made without departing from the broad inventive concept. For example, any type of packaged or unpackaged stemming 20 may be used provided that the stemming is able to be compacted by or otherwise absorb the pressure generated following initiation of the energetic material.

However as previously described, liquids that have the characteristic of increased viscosity with increased shear would be suitable. Further, it is noted that in embodiments shown in Figure 1, the plug 22 is provided with a cross bar 26. In a variation, instead of placing a mass on the plug 22, bolts or pegs may be driven through or about the cross bar 26 to mechanically hold the plug. However, it is believed that this variation would lead to increased costs due to the additional labour and plant required. Additionally the cross bar

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26 could be replaced with a plate. Also, it is preferred that the plug 22 is of a length or disposed so that its lower end when inserted into the hole is at a level substantially adjacent or below the collar area of the hole 12. It will be appreciated that the collar area C varies in accordance with the hole configuration and the nature of the material in which
5 the hole 12 is made.

All such modifications and variations together with those that would be apparent to a person of ordinary skill in the art are deemed to be within the scope of the present invention the nature of which is to be determined from the above description and the
10 appended claims.

The Claims Defining the Invention are as Follows:

1. A method of charging a hole including the steps of:
 - 5 (a) inserting an energetic material and an initiator into the hole;
 - (b) filling the hole to a predetermined level with an energy absorbing stemming material;
 - 10 (c) mechanically retaining the stemming material in the hole by providing a plug and inserting the plug into the hole and mechanically holding the plug in the hole.
2. The method according to claim 1 wherein the plug is further provided with means
15 for facilitating the coupling of the initiator with an initiation source.
3. A method of charging a hole including the steps of:
 - 20 (a) inserting an energetic material and an initiator into the hole;
 - (b) filling the hole to a predetermined level with an energy absorbing stemming material;
 - 25 (c) providing a multicomponent plug and inserting the plug into the hole to rest on the stemming material, the plug being provided with a means for facilitating the coupling of the initiator with an initiation source;
 - (d) moving the components of the plug relative to each other to create a
30 wedging action to mechanically hold the plug in the hole.
4. The method according to claim 3 wherein said step for providing said multicomponent plug includes providing a plug having at least two components



that can be moved relative to each other to increase the outer diameter of the plug as a whole to wedge the plug in the hole.

5. A method of charging a hole including the steps of:

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(a) inserting an energetic material and an initiator into the hole;

(b) filling the hole to a predetermined level with an energy absorbing stemming material;

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(c) inserting a plug into the hole to rest on the stemming material the plug being provided with means for facilitating the coupling of the initiator with an initiation source; and

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(d) mechanically holding the plug in the hole to prevent substantial movement of said plug away from the bottom of the hole, whereby, in use, on coupling of said initiator to said source via said plug, said energetic material is initiated providing a rapid increase in gas pressure near the bottom of the hole and said stemming material acts to absorb pressure generated by said gas acting away from the bottom of the hole to substantially isolate said plug from said gas pressure and concentrating the action of said gas pressure on the bottom of the hole.

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6. The method according to claim 5 wherein step (b) comprises filling the hole to a level substantially adjacent or below the collar area of the hole.

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7. The method according to claim 6 wherein step (c) above, includes providing a plug with an aperture or recess through which a lead can pass from said initiator to said initiation source to facilitate coupling therebetween; and, threading said lead through said aperture or recess when inserting the plug into said hole.

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8. The method according to claim 7 wherein step (c) above, includes providing said

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plug with a transducer for facilitating wireless electromagnetic coupling of said initiator to said initiation source.

9. The method according to claim 5 wherein step (d) comprises bearing or placing a mass on an upper end of said plug.
10. The method according to claim 5 wherein step (d) includes wedging the plug in the hole.
11. A method of producing a charged hole in a hard material to be fragmented, said method including the steps of:
- (a) providing a drill for drilling a hole in said hard material;
 - (b) inserting an energetic material and an initiator into said hole;
 - (c) stemming the hole up to a predetermined level with energy absorbing material;
 - (d) inserting a plug into the hole to rest on said stemming, the plug being provided with means for facilitating the coupling of the initiator with an initiation source; and,
 - (e) mechanically holding said plug in the hole to prevent substantial movement of said plug away from the bottom of said hole, whereby, in use, on coupling of said initiator to said source by said plug, said energetic material is initiated providing a rapid increasing gas pressure near the bottom of the hole and said stemming acts to absorb gas pressure acting away from the bottom of the hole thereby substantially isolating said plug from said gas pressure.
12. The method according to claim 11 wherein step (e) comprises bearing at least a



portion of the weight of said drill on an upper end of said plug.

13. A stemming bar for stemming a hole in a hard material the hole having a charge of energetic material at the bottom thereof, the stemming bar including a first opening at a first end, a second opening distant the first opening so that when the first end of the stemming bar is placed in a hole, the second opening is outside the hole, and a slot, passage or recess extending between the first and second openings through which an initiator means can be delivered for initiating or detonating the energetic material in the hole.
14. The stemming bar of claim 13 further provided with means at its first end to facilitate attachment to a container bearing said energetic material, so that when the stemming bar is inserted into the hole, the energetic material is simultaneously placed in the hole.
15. A method charging a hole to effect the fracturing of hard material including the steps of:
drilling a hole in the hard material;
placing a quantity of energetic material in the hole;
providing a stemming bar formed with a slot, passage or recess having a first opening at a first end of the bar adapted for insertion into the hole and a second opening spaced from the first opening by a distance so that the second opening is external to the hole;
inserting the stemming bar with said first end first into the hole;
delivering initiator means through said second opening, down said slot, passage or recess and out said first opening and into operational contact with the energetic material so that the initiator means can initiate the energetic material to effect fracturing of the hard material.
16. The method of claim 15 further including the step of mechanically holding or retaining the stemming bar in the hole.



This Sheet Has Been Replaced



17. The method of claim 16 wherein the step of placing the energetic material in the hole includes supporting the energetic material at the first end of the stemming bar so that the energetic material is placed in the hole by insertion of the first end of the stemming bar into the hole.
18. The method of claim 17 wherein the step of supporting the energetic material at the first end of the stemming bar includes providing a container for containing the energetic material and attaching the container to the first end of the stemming bar and in communication with said first opening.
19. The method of claim 15 wherein initiator means is in any form that can be delivered through the slot, passage or recess in the stemming bar and can include for example a detonator, an electric match, a non electric igniter, a length of fuse cord; or a flame directed down the slot, passage or recess.
20. The method of claim 11 wherein step (c) includes stemming the hole with cuttings provided by said drill during said drilling step.

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