

Señora

Directora de la Dirección de Nuevas Creaciones

Superintendencia de Industria y Comercio

Ministerio de Comercio, Industria y Turismo

E. S. D.

Re.: Expediente No. **NC2019/0014945**

Solicitud de registro Patente PCT entrada en Fase Nacional, para:

**“MÉTODO Y APARATO PARA EVITAR QUE FRAGMENTOS DE ROCA
INGRESEN O COLAPSEN DENTRO DE UN BARRENO”.**

Solicitante: **TBS MINING SOLUTIONS PTY LTD**

RESPUESTA OFICIO DE FORMA

Yo, **MARGARITA CASTELLANOS ABONDANO**, mayor de edad, identificada y domiciliada como aparece al pie de mi firma, obrando en mi calidad de apoderada de la sociedad solicitante del asunto citado en la referencia, en atención a su oficio **No. 322** notificado el 14 de enero de 2020, me permito dar respuesta al mismo de la siguiente manera:

1. Capítulo I o II

Se aclara que la presente solicitud es capítulo II y se anexan los resultados del estudio preliminar de patentabilidad en fase internacional (IPRP).

2. Poder

Se adjunta documento de poder debidamente conferido por **TBS MINING SOLUTIONS PTY LTD** y por lo tanto, esta objeción se debe tener por superada.

3. Cesión

Se adjunta al presente memorial documento de cesión del inventor:

Gregory Patching

a **TBS MINING SOLUTIONS PTY LTD** junto con su traducción al Español y por lo tanto, esta objeción se debe tener por superada.

4. Conclusión

Teniendo en cuenta lo anterior, es posible establecer que se cumplen los requisitos formales dispuestos en el artículo 39 de la Decisión 486.

5. Anexos

- Documento de poder debidamente conferido por **TBS MINING SOLUTIONS PTY LTD**
- Documento de cesión junto con su traducción al Español
- IPRP junto con su traducción al español

Señora Directora,



Margarita Castellanos Abondano

C.C. No. **39.779.654** de Bogotá

T.P.A. No. **70.819** del C. S. J.

Calle 94 A No. 7 A-09 - Bogotá, D.C.

Teléfono (PBX): 7560770

Bogotá,
MCA/mg
P5373

COLOMBIA

PODER

El (los) TBS Mining Solutions Pty Ltd

Domiciliados en 15 Ogilvie Road Mount Pleasant, Western Australia 6153 (AU)

Nombran por el presente a XIMENA CASTELLANOS A. y/o MARGARITA CASTELLANOS A. abogadas con oficinas en la Calle 94A No. 7A-09, Bogotá-Colombia para obtener la protección de mi (nuestra) propiedad Industrial e intelectual y con este fin autorizamos a dichos apoderados para que nos representen ante cualesquiera autoridades o personas de los órdenes administrativo, contencioso –administrativo y judicial en todo lo relacionado con los siguientes actos y gestiones:

a) Obtención de patentes de invención, modelos y dibujos industriales; registro de marcas de fabrica, de servicio, colectivas de certificación o defensivas y de denominaciones de origen, depósito de nombres y enseñas comerciales; su renovación, prórroga, inscripción de traspaso y cambio de nombre o domicilio, cancelación voluntaria y el registro de licencias de uso de esos derechos o la desanotación del registro de licencias de uso sobre esos derechos y la constitución y registro de prenda o garantías sobre dichos derechos.

b) Para la obtención de protección de variedades vegetales

c) Para la obtención de registros sanitarios;

d) Para la obtención de registros de derechos de autor.

e) Para obtener registros y transferencias de nombres de dominio

f) Acciones de oposición, observación, cancelación, nulidad, medidas cautelares y en general los juicios civiles, penales, administrativos o contencioso - administrativos que promovamos o se nos promuevan.

Pudiendo en todos los actos y gestiones arriba mencionados sustituir éste mandato entre los apoderados, transigir, desistir, recibir, cancelar, renunciar, aceptar notificaciones y nombrar apoderados judiciales y extra-judiciales. . Finalmente, este poder ratifica la validez de todos los actos y solicitudes que, a nombre de la poderdante hubieren realizado los apoderados en relación con las facultades anteriormente enumeradas, antes de la suscripción del presente poder

Dado y firmado hoy 09/01/2020

en Perth, Australia

por David Kelly (Director)

(firma ilegible)

CASTELLANOS & Co.

INTELLECTUAL PROPERTY LAW FIRM

CALLE 94 A No. 7 A – 09 / P.O. BOX 6349
PHONE (57 1) 756 07 70 / FAX (57 1) 755 01 58
BOGOTÁ D.C. COLOMBIA
castellanos@castellanosyco.co

POWER OF ATTORNEY

I (we) the undersigned TBS Mining Solutions Pty Ltd

Of 15 Ogilvie Road, Mount Pleasant, Western Australia 6153, Australia

hereby grant(s) Power of Attorney to XIMENA CASTELLANOS A. and for MARGARITA CASTELLANOS a. attorneys residing at Calle 94A No. 7A-09, Bogotá-Colombia, to obtain the protection of my (our) Intellectual Property, for which purpose we authorize the said attorneys to represent us before any authorities, or persons, specially those, administrative, contentious and judicial, in all matters concerning the following:

a) Obtainment of patents, models and designs, registration of trademarks, service, collective, certification and defensive marks, and of designations of origin; the deposit of trade names and ensigns; its renewal, extension, recordal of assignments, change of name or domicile, voluntary cancellation, and the registration of licenses of use of the above rights; or the withdrawal of the registration of license of use over such rights, the constitution and registration of pledges or security interests over these rights.

b) For the obtainment of plant variety protection

c) For the obtainment of Sanitary registrations;

d) For the obtainment of copyright registrations

e) For domain name registrations and assignment

f) Actions of opposition, cancellation, nullity, infringement, granting of licenses; and in general the civil, criminal and administrative suits related to those rights; actions and suits instituted by us or against us;

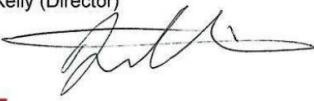
In all the above matters they may substitute this power of attorney within the appointed attorneys, compromise, cancel, receive, withdraw, renounce, accept notifications and appoint attorneys in fact in or out of court.

Finally, this power of attorney ratifies the validity of all acts and applications made by the representatives in the name of the signatory of this power of attorney, with regard to the faculties above given, before the execution of the present power of attorney.

Given and signed this 09/01/2020 (Date)

in Perth, Australia

by David Kelly (Director)



CONFIRMATORY ASSIGNMENT

THIS DEED IS MADE the 9th day of JANUARY 2020

BETWEEN Gregory Patching of 37 Kingsall Road, Attadale, Western Australia, 6156 Australia (the Assignor)

AND TBS Mining Solutions Pty Ltd of 15 Ogilvie Rd, Mount Pleasant, Western Australia, 6153, Australia (the Assignee)

RECITALS

- A. The Assignee is the applicant named in the applications for the grant of a patent set out in the Schedule (the Patent Applications) in respect of the inventions the titles of which are set out in the Schedule (the Inventions).
- B. The Assignor is the inventor of the Inventions and a director of the Assignee, and made the Inventions in the capacity of director for the exclusive benefit of the Assignee.
- C. The parties have executed this Deed to confirm the Assignee's ownership of all rights in relation to the Inventions and the Patent Applications from the date the Inventions were made, and in consideration of the payment of the sum of \$1.00 by the Assignee to the Assignor, receipt of which is acknowledged by the Assignor.

THIS DEED WITNESSES

1. ASSIGNMENT

- 1.1 The Assignor acknowledges that the Assignee was entitled to exclusive ownership of all rights in relation to the Inventions, including the right to apply for the grant of patents in respect of the Inventions in any country of the world, from the date the Inventions were made.
- 1.2 For the avoidance of doubt, the Assignor assigns absolutely to the Assignee, with effect from the date of this Deed, the whole of its title to and rights in relation to the Inventions and the Patent Applications (if any).
- 1.3 The acknowledgement in clause 1.1 and the assignment effected by clause 1.2 include any rights of the Assignor to:
 - (a) claim priority from the Patent Applications in respect of applications made for the grant of a patent anywhere in the world; and
 - (b) bring legal proceedings, and to obtain any relief to which the Assignor was entitled immediately before executing this Deed (if any), in respect of any infringement of the Assignor's rights in relation to the Patent Applications or the Inventions which occurs before or after the date of this Deed.
- 1.4 The Assignor agrees to provide any assistance reasonably required by the Assignee in order to give full effect to this Deed (including the execution of any documents). The Assignor irrevocably appoints each of the directors of the Assignee (or the Assignee, if the Assignee is an individual) from time to time severally as the Assignor's attorney to do all acts and execute all documents which the Assignor is obliged to do or execute by this clause.

2. GENERAL

- 2.1 In this Deed, unless the context does not permit it:
- (a) a reference to the singular includes the plural and vice versa;
 - (b) a reference to any gender includes all other genders; and
 - (c) any form of the word "include" does not imply any limitation.
- 2.2 This Deed (and the validity and enforceability of this Deed) is governed by and to be interpreted in accordance with the law of the State of Victoria. The parties submit to the exclusive jurisdiction of the courts of Victoria, and the federal courts of the Commonwealth of Australia.
- 2.3 This Deed may be signed in multiple copies, all of which shall constitute a single Deed and each of which shall be deemed to be an original.
- 2.4 This Deed may be signed in counterparts. If this Deed is signed in counterparts, it shall not be legally enforceable until the parties exchange the signed counterparts, which may be by electronic means. If exchange is carried out electronically, each party must promptly deliver a hard copy of this Deed executed by it to the other party, but failure to do so will not affect the enforceability of this Deed.
- 2.5 The rights and obligations of the parties under this Deed do not merge on completion of any transaction contemplated by this Deed.

3. AUTHORITY TO EXECUTE

- 3.1 Each of the parties warrants its power to enter into this Deed.
- 3.2 Any individual executing this Deed on behalf of a party warrants that he or she has been fully empowered to execute this Deed and that all necessary action to authorise execution of this Deed has been taken.

SCHEDULE

Country	Number	Title	Filing Date
Australia	2017902834	A METHOD AND APPARATUS FOR PREVENTING ROCK FRAGMENTS FROM ENTERING A BLAST HOLE	19.07.2017
Australia	2017903102	A METHOD AND APPARATUS FOR PREVENTING ROCK FRAGMENTS FROM ENTERING A BLAST HOLE	04.08.2017
Australia	2017903341	A METHOD AND APPARATUS FOR PREVENTING ROCK FRAGMENTS FROM ENTERING OR COLLPASING INTO A BLAST HOLE	18.08.2017
Australia	2017904880	A METHOD AND APPARATUS FOR PREVENTING ROCK FRAGMENTS FROM ENTERING OR COLLPASING INTO A BLAST HOLE	04.12.2017

Country	Number	Title	Filing Date
International	PCT/AU2017/050752	A METHOD AND APPARATUS FOR PREVENTING ROCK FRAGMENTS FROM ENTERING OR COLLAPSING INTO A BLAST HOLE	18.07.2018

EXECUTED AS A DEED
SIGNED, SEALED AND DELIVERED by
Gregory Patching


.....
(Signature)

in the presence of

SHANE LITCHFIELD
.....
(Name of Witness)


.....
(Signature of Witness)

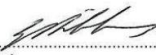
Date: 9th JANUARY 2020

EXECUTED for and on behalf of TBS Mining
Solutions Pty Ltd

by DAVID KELLY.....(Name)
(Director/Secretary/Sole Director and Secretary)

by GREGORY PATCHING.....(Name)
(Director)


.....
(Signature)


.....
(Signature)

09/01/2020.
.....
(Date)

9th JANUARY 2020
.....
(Date)

CESIÓN CONFIRMATORIA

El acuerdo es elaborado el 9 de enero de 2020.

Entre Gregory Patching de 37 Kingsall Road, Attadale, Western Australia, 6156 Australia (el cedente)

Y TBS Mining Solutions Pty Ltd de 15 Ogilvie Rd, Mount Pleasant, Western Australia, 6153, Australia (el cesionario)

CONSIDERACIONES

A. El cesionario es el solicitante mencionado en las solicitudes para la concesión de un juego de patentes en el anexo (las solicitudes de patentes) con respecto a las invenciones de títulos tal como se indican en el anexo (las invenciones).

B. El cedente es el inventor de las invenciones y un director del cesionario, quién hizo las invenciones en la capacidad de director para el beneficio exclusivo del cesionario.

C. Las partes han ejecutado este acuerdo para confirmar la titularidad del titular de todos los derechos relacionados con las invenciones y las solicitudes de patentes desde la fecha en que las invenciones se realizaron, y en consideración del pago de \$1.00 por el cesionario al cedente, del cual acusa recibo el cedente.

LOS TESTIGOS DEL ACUERDO

1. CESIÓN

1.1 El cedente reconoce que el cesionario tenía derecho exclusivo sobre la titularidad de los derechos en relación con las invenciones, incluido el derecho a aplicar para la concesión de las patentes con respecto a las invenciones en cualquier país del mundo, desde la fecha en que dichas invenciones fueron realizadas.

1.2 Para evitar cualquier duda, el cedente traspasa absolutamente al cesionario, desde la fecha de este acuerdo, todos los títulos y derechos en relación con las invenciones y las solicitudes de patentes (si hay alguna).

1.3 El reconocimiento de la cláusula 1.1 y la cesión de la cláusula 1.2 incluye todos los derechos del cedente a:

(a) reivindicar prioridad de las solicitudes de patentes con respecto a las solicitudes realizadas para la concesión de una patente en cualquier lugar del mundo; y

(b) entablar acciones judiciales, y obtener cualquier alivio para el cual el cedente tenía derecho antes de ejecutar este acuerdo (si hay alguno), con respecto a cualquier infracción de los derechos del cedente en relación con las solicitudes de patentes o las invenciones que hayan ocurrido antes o después de la fecha de este acuerdo.

1.4 El cedente está de acuerdo con proporcionar asistencia razonable requerida por el cesionario con el fin de dar efecto a este acuerdo (incluyendo la ejecución de cualquier documento). El cedente de manera irrevocable nombra a cada uno de los directores del cesionario (o el cesionario, si el cesionario es un individuo) de vez en cuando solidariamente para que el abogado del cesionario realice todos los actos y ejecute todos los documentos que el cedente está obligado a ejecutar por esta cláusula.

2. GENERAL

2.1 En este acuerdo, a menos que el contexto no lo permita:

- (a) una referencia al singular incluye el plural y viceversa;
- (b) una referencia a cualquier género incluye los otros géneros; y
- (c) cualquier forma de la palabra “incluye” no implica una limitación

2.2 Este acuerdo (y la validez y exigibilidad de este acuerdo) es gobernado por y para ser interpretado de acuerdo con las leyes del estado de Victoria. Las partes se someten a la jurisdicción exclusiva de las cortes de Victoria, y las cortes federales de la comunidad de Australia.

2.3 Este acuerdo puede ser firmado en múltiples copias, todas las cuales deben constituir un solo acuerdo y cada una debe considerarse como original.

2.4 Este acuerdo puede ser firmado en contrapartes. Si este acuerdo es firmado en contrapartes, no debe ser legalmente exigible hasta que las partes intercambien las contrapartes firmadas, lo cual puede hacerse por medios electrónicos. Si el intercambio se realiza electrónicamente, cada parte debe prontamente entregar una copia física de este acuerdo ejecutado a la otra parte pero la falla de realizarlo no afectará la exigibilidad de este acuerdo.

2.5 Los derechos y obligaciones de las partes bajo este acuerdo no se fusionan al completar cualquier transacción contemplada en este acuerdo.

3. AUTORIDAD PARA EJECUTAR

3.1 Cada una de las partes garantiza su poder para entrar en este acuerdo.

3.2 Cualquier individuo ejecutando este acuerdo de parte de una de las partes debe garantizar que él o ella haya sido empoderado completamente para ejecutar el acuerdo y que toda acción necesaria para autorizar su ejecución ha sido tomada.

ANEXO

País	Número	Título	Fecha de solicitud
Australia	2017902834	MÉTODO Y APARATO PARA EVITAR QUE FRAGMENTOS DE ROCA INGRESEN O COLAPSEN DENTRO DE UN BARRENO	19.07.2017
Australia	2017903102	MÉTODO Y APARATO PARA EVITAR QUE FRAGMENTOS DE ROCA INGRESEN O COLAPSEN DENTRO DE UN BARRENO	04.08.2017
Australia	2017903341	MÉTODO Y APARATO PARA EVITAR QUE FRAGMENTOS DE ROCA INGRESEN O COLAPSEN DENTRO DE UN BARRENO	18.08.2017
Australia	2017904880	MÉTODO Y APARATO PARA EVITAR QUE FRAGMENTOS DE ROCA INGRESEN O COLAPSEN DENTRO DE UN BARRENO	04.12.2017

Internacional	PCT/AU2017/050752	MÉTODO Y APARATO PARA EVITAR QUE FRAGMENTOS DE ROCA INGRESEN O COLAPSEN DENTRO DE UN BARRENO	18.07.2018

Ejecutado como un acuerdo

Firmado, sellado y entregado por

Gregory Patching

(firma ilegible)

Firma

En la presencia de

(nombre ilegible)

Nombre de testigo

(firma ilegible)

Firma del testigo

Fecha: 9 Enero 2020

Ejecutado por y en parte de TBS Mining
Solutions Pty Ltd

Por David Kelly (nombre)
(Director/Secretario/único director y secretario)

Por (Greg Patching) (nombre) (director)

(firma ilegible)
Firma

09/01/2020
(fecha)

(firma ilegible)
Firma

9 de enero de 2020
(fecha)

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 3674	FOR FURTHER ACTION See Form PCT/IPEA/416																	
International application No. PCT/AU2018/050752	International filing date (<i>day/month/year</i>) 18 July 2018	Priority date (<i>day/month/year</i>) 19 July 2017																
International Patent Classification (IPC) or national classification and IPC F42D 1/08 (2006.01)																		
Applicant TBS MINING SOLUTIONS PTY LTD																		
1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36. 2. This REPORT consists of a total of 5 sheets, including this cover sheet. 3. This report is also accompanied by ANNEXES, comprising: a. ☒ (<i>sent to the applicant and to the International Bureau</i>) a total of 51 sheets, as follows: ☒ sheets of the description, claims and/or drawings which have been amended and/or sheets containing rectifications authorized by this Authority, unless those sheets were superseded or cancelled, and any accompanying letters (see Rules 46.5, 66.8, 70.16, 91.2, and Section 607 of the Administrative Instructions). ☐ sheets containing rectifications not taken into account by this Authority because they were not available at the time when this Authority began to draw up this report, and any accompanying letters (Rules 66.4bis, 70.2(e), 70.16 and 91.2). ☐ Superseded sheets and any accompanying letters, where this Authority either considers that the superseding sheets contain an amendment that goes beyond the disclosure in the international application as filed, or the superseding sheets were not accompanied by a letter indicating the basis for the amendments in the application filed, as indicated in item 4 of Box No. I and the Supplemental Box (see Rule 70.16(b)). b. ☐ (<i>sent to the International Bureau only</i>) a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing, in the form of an Annex C/ST.25 text file, as indicated in the Supplemental Box Relating to Sequence Listing (see paragraph 3ter of Annex C of the Administrative Instructions). 4. This report contains indications relating to the following items: <table style="margin-left: 20px; border: none;"> <tr><td>☒ Box No. I</td><td>Basis of the report</td></tr> <tr><td>☐ Box No. II</td><td>Priority</td></tr> <tr><td>☐ Box No. III</td><td>Non-establishment of opinion with regard to novelty, inventive step and industrial applicability</td></tr> <tr><td>☐ Box No. IV</td><td>Lack of unity of invention</td></tr> <tr><td>☒ Box No. V</td><td>Reasoned statement under Article 35(2) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement</td></tr> <tr><td>☐ Box No. VI</td><td>Certain documents cited</td></tr> <tr><td>☐ Box No. VII</td><td>Certain defects in the international application</td></tr> <tr><td>☒ Box No. VIII</td><td>Certain observations on the international application</td></tr> </table>			☒ Box No. I	Basis of the report	☐ Box No. II	Priority	☐ Box No. III	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability	☐ Box No. IV	Lack of unity of invention	☒ Box No. V	Reasoned statement under Article 35(2) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement	☐ Box No. VI	Certain documents cited	☐ Box No. VII	Certain defects in the international application	☒ Box No. VIII	Certain observations on the international application
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☒ Box No. VIII	Certain observations on the international application																	
Date of submission of the demand 17 January 2019	Date of completion of this report 8 July 2019																	
Name and mailing address of the IPEA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA Email address: pct@ipaaustralia.gov.au		Authorised officer Jude Fernando AUSTRALIAN PATENT OFFICE (ISO 9001 Quality Certified Service) Telephone No. +61262832419																

Box No. I

Basis of the report

1. With regard to the **language**, this report has been established on the basis of:
- ☒ The international application in the language in which it was filed:
- ☐ A translation of the international application into , which is the language of a translation furnished for the purposes of :
- ☐ international search (under Rules 12.3(a) and 23.1 (b)).
- ☐ publication of the international application (under Rule 12.4(a)).
- ☐ international preliminary examination (Rules 55.2(a) and/or 55.3(a) and (b)).
2. With regard to the **elements** of the international application, this report is based on (*replacement sheets which have been furnished to the receiving office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report*):
- ☐ the international application as originally filed/furnished, or
- ☒ the description: pages , as originally filed/furnished
pages **1-19** , received by this Authority on **17 January 2019** with the letter of **17 January 2019**
- ☒ the claims: Nos. , as originally filed/furnished
Nos. , as amended (together with any statement) under Article 19,
Nos. **1-20** , received by this Authority on **17 January 2019** with the letter of **17 January 2019**
- ☒ the drawings: pages **1/5 - 5/5** , as originally filed/furnished
pages , received by this Authority on with the letter of
- ☐ a sequence listing - see Supplemental Box Relating to Sequence Listing.
3. ☐ The amendments have resulted in the cancellation of:
- ☐ the description, pages
- ☐ the claims, Nos.
- ☐ the drawings, sheets/figs
- ☐ the sequence listing (specify):
4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since either they are considered to go beyond the disclosure as filed, or they were not accompanied by a letter indicating the basis for the amendments in the application as filed, as indicated in the Supplemental Box (Rules 70.2(c) and (*c-bis*)):
- ☐ the description, pages
- ☐ the claims, Nos.
- ☐ the drawings, sheets/figs
- ☐ the sequence listing (specify):
5. ☐ This report has been established:
- ☐ taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rules 66.1(d-*bis*) and 70.2(e)).
- ☐ without taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rules 66.4*bis* and 70.2(e)).
6. With regard to top-up searches (Rules 66.1*ter* and 70.2(f)):
- ☒ A top-up search was carried out by this Authority on 4 July 2019.
- ☐ Additional relevant documents have been discovered during the top-up search.
- ☐ No top-up search was carried out by this Authority because it would serve no useful purpose.
7. ☐ Supplementary international search report(s) from Authority(ies)
has/have been received and taken into account in establishing this report (Rule 45*bis*.8(b) and (c)).

* If item 4 applies, some or all of those sheets may be marked "superseded."

Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement**1. Statement**

Novelty (N)	Claims 1-20	YES
	Claims NONE	NO
Inventive step (IS)	Claims 1-20	YES
	Claims NONE	NO
Industrial applicability (IA)	Claims 1-20	YES
	Claims NONE	NO

2. CITATIONS AND EXPLANATIONS:**CITATIONS**

D1: AU 199964504 A1 (SANLEO HOLDINGS PTY LTD) 24 August 2000

D2: US 4055122 A (MULDROW, JR.) 25 October 1977

NOVELTY (N)

None of the above documents D1 and D2, discloses, amongst other features of Claim 1, *a resiliently flexible sheet, including a pair of spaced apart longitudinally extending side edges and a pair of spaced apart laterally extending end edges, the sheet having a curved form defining a longitudinal passage extending between openings at longitudinally opposite ends, one end of the curved sheet being insertable into the open end of a blast hole where in in the curved form the side edges of the sheet are free and the sheet biases towards a flat form whereby the external surface of the curved sheet is biased against an internal surface of the blast hole to form a barrier to prevent surrounding loose rock fragments from falling or collapsing into the open end of the blast hole, as claimed in Claim 1.*

Similar observations apply to Claims 9, 12 and 16 for the same reasons. Therefore, the subject matter of Claims 1, 9, 12 and 16 is new and meets the requirements of Article 33(2) of the PCT with regard to novelty.

Claims 2–8, 10–11, 13–15 and 17–20 depend on Claims 1, 9, 12 and 16, respectively, and define further features to those defined in the independent claims. Therefore, the subject matter of these claims is also new and meets the requirements of Article 33(2) of the PCT with regard to novelty.

INVENTIVE STEP (IS)

None of the above prior art documents either individually or in combination obviously suggests to a person skilled in the art, *a resiliently flexible sheet, including a pair of spaced apart longitudinally extending side edges and a pair of spaced apart laterally extending end edges, the sheet having a curved form defining a longitudinal passage extending between openings at longitudinally opposite ends, one end of the curved sheet being insertable into the open end of a blast hole where in in the curved form the side edges of the sheet are free and the sheet biases towards a flat form whereby the external surface of the curved sheet is biased against an internal surface of the blast hole to form a barrier to prevent surrounding loose rock fragments from falling or collapsing into the open end of the blast hole, as claimed in Claim 1.*

Similar observations apply to Claims 9, 12 and 16 for the same reasons. Therefore, the subject matter of Claims 1, 9, 12 and 16 is not obvious and meets the requirements of Article 33(3) of the PCT with regard to inventive step.

Claims 2–8, 10–11, 13–15 and 17–20 depend on Claims 1, 9, 12 and add further aspects of the inventive concept. Therefore, the subject matter of these claims is also not obvious and meets the requirements of Article 33(3) of the PCT with regard to inventive step.

INDUSTRIAL APPLICABILITY (IA)

The invention defined in the claims is considered to meet the requirements of Industrial Applicability under Article 33(4) of the PCT because it can be made by, or used in, industry.

Claim 1 recites '*....whereby and external surface of the curved sheet is biased against....*'. It appears that this should correctly read as '*....whereby an external surface of the curved sheet is biased against....*'.

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Patent Attorneys

Trade Mark Attorneys

Intellectual Property Lawyers

Gestalt Law Pty Ltd
ABN 95 705 440 932
ACN 611 286 438

GPO Box 683
Sydney NSW 2001
Australia

P +61 2 8319 2020
M +61 4 22 625 569

www.gestalt.law
mail@gestalt.law

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Ltd are members of the scheme

By ePCT
The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva
SWITZERLAND

Chapter II Demand and Article 34 Amendments

Application No. : PCT/AU2018/050752
Applicants : TBS Mining Solutions Pty Ltd
**Title : A METHOD AND APPARATUS FOR
PREVENTING ROCK FRAGMENTS FROM
ENTERING OR COLLAPSING INTO A BLAST
HOLE**
Our Ref : 3674

We hereby file a Demand for International Preliminary Examination under Chapter II in respect of the above International Patent Application.

Also enclosed are amendments to the description and claims of the specification filed under Article 34 of the PCT for consideration. In this regard we enclose a Statement of Proposed Amendments and a marked and a clean copy of the amendments.

Amendments

To further clarify the scope of the invention the claims have been revised. In particular, independent claim 1 has been revised to define:

*An apparatus for preventing surrounding loose rock fragments from falling or collapsing into a blast hole, the apparatus including:
a resiliently flexible sheet including a pair of spaced apart longitudinally extending side edges and a pair of spaced apart laterally extending end edges, the sheet having a curved form defining a longitudinal passage extending between openings defined by the end edges at longitudinally opposite ends, one end of the curved sheet being insertable into the open end of a blast hole, wherein in the curved form the side edges of the sheet are free and the sheet biases towards a flat form whereby an external surface of the curved sheet is biased against an internal surface of the blast hole to form a barrier preventing surrounding loose rock fragments from falling or collapsing into the open end of the blast hole.*

As amended, claim 1 recites “in the curved form the side edges of the sheet are free” (i.e. unconnected to each other). Support for this amendment can be found throughout the specification at paragraphs [0010], [0011] and in the drawings, in particular Figures 3, 4, 5, 8 and 9.

Claim 1 is further revised to clarify that in the curved form the sheet defines a longitudinal passage with openings “defined by the end edges” at longitudinally opposite ends of the passage. Support for this amendment can be found throughout the specification including at paragraph [0047] and in Figures 3, 4, 5, 8 and 9.

As amended, claim 1 further recites “in the curved form... the resilient sheet biases towards a flat form”. Support for this amendment is found in claim 3 and paragraph [009] of the specification.

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As amended, claim 1 further recites “whereby an external surface of the curved sheet biases against an internal surface of the blast hole”. Support for this amendment is found throughout the specification including in paragraphs [0020] and [0049].

Independent claim 9, previously claim 10, and independent claim 12 have been similarly amended. Claim 3 has been deleted and new claim 11 has been included. Support for new claim 11 is found in the specification including at paragraphs [0037] and [0052] and Figure 4.

Novelty and Inventive Step

In the ISR and the WO there are 2 references are cited, namely:

D1: AU 199964504 A1 (SANLEO HOLDINGS PTY LTD) 24 August 2000

D2: US 4055122 A (MULDROW, JR.) 25 October 1977

In the WO, at page 3, the Examiner asserts that:

Claims 5, 7-9 and 16-20 are novel;
Claims 17-20 are novel and inventive; and
Claims 1 to 4, 6 and 10 to 15 are not novel or inventive.

D1: AU 199964504 A1 (SANLEO HOLDINGS PTY LTD)

This is the only reference cited in the ISR and WO in relation to the novelty and inventiveness of the claimed invention. This reference relates to lining of blast-holes, in particular inserting a liquid impermeable liner into a blast hole and filling the liner with explosive. Among other things, the liner enables non water-proof explosives to be used (page 15, lines 3 to 5).

The Examiner refers to Figures 2 and 4B and page 10, line 6 of the specification, as disclosing an apparatus that includes all of the features of the presently claimed invention. More broadly, this part of the cited reference discloses “a combination of the bore hole lining of the invention and means to support the open end to maintain open the open end to facilitate insertion of explosive into the lining and to support the open end proximate the mouth of a bore hole” (page 9 line 35 to page 10, line 2). “The support means may be of any shape, however it is preferable that the support means is a cone shaped support means (generally a hollow cone shape). The support means is of such size as to dip into the sleeve yet jam into the top of the bore hole. Typically the support means is made from cardboard; corrugated cardboard; plastic, for example a flower pot with the closed end removed; wood; metal or ceramics. Typically the support means is made of cardboard or plastic... In another form, the support means is a cone or ring or other suitable shape with a means to support the cone or ring (which may be circular, rectangular, square, elliptical or other suitable shape) which could be legs (e.g. two, three, four or five legs). In yet another form the support means is an annularly splayed device”. (page 10, lines 3 to 23).

Accordingly, D1 broadly discloses a support means made of cardboard or plastic formed into a fixed conical shape (although a “ring” shaped alternative is mentioned, but not illustrated) to hold open the liner at the top of the blast hole to allow explosive to be deposited into the liner. Two embodiments of the support means are disclosed in the figures including:

- a conical shaped funnel that is placed into the top of the liner and wedged against the lip of the blast hole and folding the liner over the top of the funnel (see Figures 2, 4B, 4C, 4D below); and
- an inverted conical shaped funnel placed on the ground around the blast hole and drawing the top of the liner through the middle of the funnel and clamping the liner to the upper open end of the inverted funnel (see Figure 9 below).

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As disclosed in D1, the support means may be formed out of a flat sheet of material folded into a conical shape and its free side edges secured together, or otherwise may be formed of a unitary conical shaped member without any joins. A ring shaped alternative embodiment is mentioned however no further details as to its structure are provided.

The disclosure of D1 suggests that a cone or ring shaped support member could include a means to support the cone or ring (which may be circular, rectangular, square, elliptical or other suitable shape) which could be legs (e.g. two, three, four or five legs). However, there is no further disclosure of a configuration or use of such embodiments.

In relation to the embodiment illustrated in Figure 2, which is reproduced below, the relevant disclosure is at page 19, lines 19-23, which provides “a support means is illustrated as a piece of cardboard which has been folded into a cone 9 and fixed in place by two pieces of sealing tape 10, 10a”.

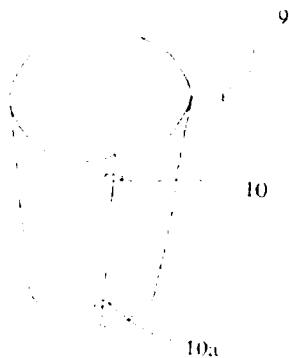


FIGURE 2

The use of the support means is illustrated in Figures 4B, 4C and 4D, reproduced below, and is described at page 20, lines 23 to 37 and page 21, lines 1 to 21. The reference discloses that “the user pushes cone 9 down into sleeve 1 until cone 9 abuts bore hole opening 14. Figure 4B shows cone 9 abutting bore hole opening 14 after it has been placed into plastic sleeve 1. In this position, cone 9 is jammed at bore hole opening 14 after it has been placed in plastic sleeve 1.” This disclosure calls for a liner to be placed into a bore-hole and a fixed-cone shaped funnel to be placed inside the open end of the liner and to be wedged against the bore hole opening. The end of the liner is then folded over the top and into the opening within the cone shaped funnel as shown in Figures 4C and 4D.

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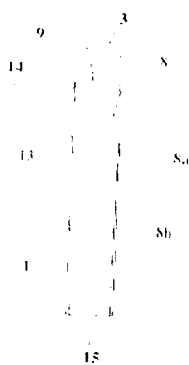


FIGURE 4B

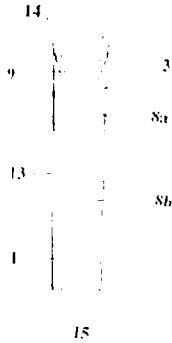


FIGURE 4C

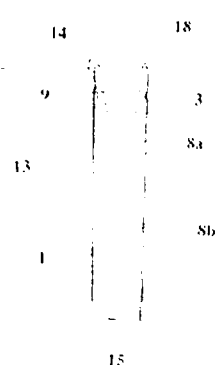


FIGURE 4D

Another embodiment is illustrated in Figure 9 and described at page 22, line 29 to page 23, line 11. This embodiment calls for the cone shaped funnel to be placed in an inverted position over the hole so that the larger diameter end rests on the ground around the bore-hole and the liner is drawn up through the smaller diameter opening above ground level and fixed thereto.

Accordingly, this reference does not teach or suggest *“a resiliently flexible sheet including a pair of spaced apart longitudinally extending side edges... wherein in the curved form the side edges of the sheet are free and the sheet biases towards a flat form whereby an external surface of the curved sheet is biased against an internal surface of the blast hole”* as called for by the presently claimed invention, as amended.

The cited reference teaches a fixed form, conical device, albeit one that may be formed out of a flat sheet with free edges fixed together, so that the funnel device can be wedged, effectively in an interference fit, into the open end of the bore hole. In contrast, the present invention calls for a device with free side edges

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such that the resilient properties of the material comprising the sheet cause it to be biased towards a flat form such that the external surface of the sheet is biased against the internal surface of the blast hole. The disclosure of D1 teaches a support device with a fixed geometry and, as such, teaches away from the present invention and its free side edges and its implicit variable geometry.

Furthermore, dependent claims 2, 10 and 13, as amended, call for the sheet to assume, in use, a substantially cylindrical form coaxially within the blast hole. In contrast, D1 teaches providing conically shaped support members into a blast hole. As such, we submit that the subject matter further defined in dependent claims 2, 10 and 13, as amended, is not taught or suggested by the cited reference and as such, recite novel and inventive subject matter.

D1 discloses at page 9, line 35 to page 10, line 2, "According to another embodiment of this invention there is provided a combination of the bore hole lining of the invention and means to support the open end to maintain open the open end to facilitate insertion of explosive into the lining and to support the open end proximate the mouth of a bore hole". Thus, the support means of D1 is intended for use to "support" the open end of a liner at the open end of the blast hole to allow it to be filled with explosive. There is no teaching or suggestion of the support means being adapted support the internal surface of the blast hole or for preventing loose rock fragment from falling or collapsing into a blast hole. There is no mention or suggestion in D1 of the problem to which the present invention relates and, therefore, a person skilled in the art would not have considered the disclosure of D1 to be relevant to addressing the problem that the present invention seeks to address.

Conclusions

The cited reference D1 does not disclose all of the features of claim 1, as amended. As such, claim 1 is novel over this reference.

Furthermore, the disclosure of D1 does not envisage the problem that the present invention seeks to overcome, namely the problem of surrounding loose rock fragments falling or collapsing into a blast hole opening, let alone teach or suggest the presently claimed invention. Therefore, D1 does not deprive the invention of claim 1, as amended, of an inventive step.

For the same reasons, we submit that independent claims 9 and 12, as amended, are also novel and involve an inventive step over D1. Also, for the reasons set out above the further subject matter recited in dependent claims 2, 10 and 13, as amended, is also not taught or suggested by the disclosure of D1 such that the subject matter recited in these claims is also novel and involves an inventive step over D1.

Favourable consideration is requested.

Respectfully
Daniel A. McKinley



Principal
daniel@gestalt.law.

A METHOD AND APPARATUS FOR PREVENTING ROCK FRAGMENTS FROM ENTERING OR COLLAPSING INTO A BLAST HOLE

TECHNICAL FIELD

[001] The present invention relates to the field of blasting, particularly in the fields of mining and quarrying.

BACKGROUND

[002] Minerals such as iron ore and coal can be recovered in a variety of methods including above ground open cut mining methods. Such methods can involve the use of blasting with bulk explosives to dislodge bulk quantities of ore for excavation and recovery through subsequent handling via excavators and the like. The blasting process results in the comminution of rock containing the ore into particles of varying sizes. It is desirable for the blasting process to produce material with an average particle size that is as small as possible to minimise the need for further comminution by crushing, grinding, vibrating and other processes.

[003] Bench blasting is a process that involves drilling holes into rock at depths, in diameters, and at spacing and filling the holes with explosive material to form a column charge that fractures the rock in a controlled manner. The blasting holes can have diameters as large as 270 to 311 or even up to 350 millimetres and larger and have depths of as much as 50 metres or more. These blast holes are filled with bulk explosive materials that are, at least in part, ammonium nitrate based low velocity explosives. The explosive material will be contacted with a primer and covered or “stemmed” with material such as aggregate. The primer is activated electrically or non-electrically to cause the explosive to detonate.

[004] Most of the rock that is fractured after a blasting operation is removed from the site by excavators for further processing or waste removal. However, significant quantities of loose rock fragments, or “preconditioned” material, can remain on the bench from the sub-drilled region after achieving the Reduced

Level (RL). It can be desirable to employ substantially increased sub-drill lengths to deliberately and significantly increase the depth of the preconditioned layer. A preconditioned layer depth of up to 4 metres or more can improve the efficiency of the comminution process by maximising the volume of fine fragmentation that results from the subsequent blasting operation.

[005] In the location where blast holes for a subsequent blasting operation are to be drilled these fragments or 'preconditioned' material remain. After blast holes have been drilled loose rock fragments or preconditioned material can collapse into the openings of completed blast holes to partially fill or even block the drill hole prior to depositing explosive material. Where up to the first four or more metres of the depth of the blast hole can be through the preconditioned layer the risk of material collapsing into blast holes can be acute. Wet environments may also lubricate the loose rock fragments, exacerbating the collapsing of loose rock fragments into the blast holes.

[006] Any discussion of background art throughout the specification should in no way be considered as an admission that any of the documents or other material referred to was published, known or forms part of the common general knowledge.

SUMMARY OF THE INVENTION

[007] Accordingly, in one aspect, the invention provides an apparatus for preventing surrounding loose rock fragments from falling or collapsing into a blast hole, the apparatus including: a resiliently flexible sheet including a pair of spaced apart longitudinally extending side edges and a pair of spaced apart laterally extending end edges, the sheet having a curved form defining a longitudinal passage extending between openings at longitudinally opposite ends, one end of the curved sheet being insertable into the open end of a blast hole, wherein in the curved form the side edges of the sheet are free and the sheet biases towards a flat form whereby an external surface of the curved sheet is biased against an internal surface of the blast hole and forms a barrier preventing surrounding loose rock fragments from falling or collapsing into the blast hole.

[008] Preferably, the sheet is adapted to be forced into a substantially cylindrical or a conical form wherein upon insertion through the open end of a blast hole the sheet assumes a substantially cylindrical form coaxially within the blast hole. Preferably, the sheet is adapted to be manipulated manually into the cylindrical or the conical form.

[009] In accordance with the invention, the sheet is formed of resiliently flexible material biased towards a substantially flat form whereby in use within the blast hole the sheet biases against the internal surface of the blast hole. Advantageously, the resilient properties of the material from which the sheet is formed cause the external surface of the sheet to be biased against the internal surface of the blast hole thereby forming a barrier preventing surrounding loose rock fragments from falling or collapsing into the blast hole.

[0010] In embodiments, the longitudinally extending side edges taper at an end thereof. When the sheet is bent over on itself, manually or otherwise, and the transversely opposite parallel edges are brought towards each other the tapering of the ends of the side edges to promote a more uniform cylindrical form of the sheet.

[0011] In embodiments, the width of the sheet between the longitudinally extending side edges is less than the circumference of the blast hole. Preferably, the sheet is adapted to assume a substantially cylindrical form within the blast hole wherein the side edges of the sheet are spaced apart. Preferably, the sheet is adapted to be forced, such as by being manually manipulated, into the cylindrical form. Alternatively, the sheet may be mechanically manipulated into the cylindrical form. In embodiments, the width of the sheet between the longitudinally extending side edges is equal to the circumference of the blast hole or is greater than the circumference of the blast hole. It is to be appreciated that a width less than the circumference of the blast hole is preferred as this allows for distortion and non-uniformity of the blast hole and also requires fewer openings in the sheet for use as hand holds thus minimising any weakening of the sheet. However, the embodiments of the sheet where the width of the sheet is equal to or greater than the circumference

of the blast hole also fulfils the broad objectives of the invention which is to form a barrier preventing surrounding loose rock fragments from falling or collapsing into the blast hole.

[0012] In embodiments, the longitudinally extending side edges taper at an end thereof. When the sheet is bent over on itself and the transversely opposite parallel edges are brought towards each other the tapering of the ends of the side edges promotes a more uniform cylindrical form for the sheet.

[0013] Preferably, the longitudinally extending side edges each include elongated flanges adapted for abutment with each other when the sheet is in the curved form.

[0014] In embodiments, the flexible sheet is comprised of a substantially flat sheet of flexible material. The flexible sheet has a normally flat form and is adapted to be rolled into the curved form. That is, in the resting state, the sheet will tend towards a substantially flat form.

[0015] In embodiments, the sheet includes at least one opening through the sheet adjacent to each longitudinally extending side edge operable as a hand hold for a user to manually roll the sheet into the curved form. In embodiments, the sheet includes at least one opening through the sheet adjacent to one of the end edges operable as a hand hold for a user to manually insert and remove the sheet relative to the open end of a blast hole.

[0016] In embodiments, the sheet includes a pair of openings through the sheet that are adapted to receive therethrough an elongated member for engaging a surface surrounding the blast hole to prevent further insertion of the panel through the opening of the blast hole. Preferably, the pair of openings are located adjacent to each longitudinally extending side edge and are aligned with each other along the length of the sheet for receiving the longitudinal member therethrough perpendicularly to the length of the sheet.

[0017] In another aspect, the invention provides a method for preventing surrounding loose rock fragments from falling or collapsing into a blast hole, the method including: providing a resiliently flexible sheet including a pair of spaced apart longitudinally extending side edges and a pair of spaced apart laterally extending end edges, forming the sheet into a curved form defining a longitudinal passage extending between openings at longitudinally opposite ends, inserting one end of the curved sheet into the open end of a blast hole wherein in the curved form the side edges of the sheet are free and the sheet biases towards a flat form whereby an external surface of the curved sheet biases against an internal surface of the blast hole and substantially coaxially therewith forming a barrier preventing surrounding loose rock fragments from falling or collapsing into the blast hole.

[0018] Preferably, the method includes locating the sheet within the blast hole within a layer of preconditioned loose rock fragments to form a barrier preventing the internal surface of the blast hole within the preconditioned layer from falling or collapsing into the blast hole. Preferably, the method can include inserting an elongated member through apertures in the sheet whereby the elongated member engages a surface surrounding the blast hole to prevent further insertion of the sheet through the open end of the blast hole.

[0019] In an embodiment, the method includes: forcing the flexible sheet into a conical form tapering in an axial direction from a larger diameter opening at one of the ends to a smaller diameter opening at the other end, inserting the smaller diameter end through the open end of a blast hole, and releasing the sheet to assume a substantially cylindrical form within the blast hole thereby forming a barrier preventing surrounding loose rock fragments from falling or collapsing into the blast hole.

[0020] In another embodiment, the method includes: forcing the flexible sheet into a cylindrical form and inserting the sheet through the open end of a blast hole and releasing the sheet whereby the sheet biases against the internal surface of the blast hole forming a barrier preventing surrounding loose rock fragments from falling or collapsing into the blast hole.

[0021] Preferably, the method includes forcing the sheet manually into the conical or the cylindrical form. Alternatively, the method may include mechanically forcing the sheet into the conical or the cylindrical form.

[0022] Embodiments of the apparatus and method are advantageous in that they provide convenient installation of a barrier in the open end of a blast hole that prevents surrounding loose rock fragments from falling or collapsing into the blast hole.

[0023] Embodiments of the apparatus and method are advantageous in that they operate to maintain an open collar for the blast hole to enable ease in depositing typical explosives and other consumables into the blast hole.

[0024] In another aspect, the invention provides a bench blasting method including: drilling blast holes through a layer of preconditioned loose rock fragments and into the stable rock below; forming a substantially flat resiliently flexible sheet into a curved form defining a longitudinal passage and openings at longitudinally opposite ends, inserting one end of the curved sheet into an open end of the blast hole wherein in the curved form the side edges of the sheet are free and the resilient sheet biases towards a flat form whereby an external surface of the curved sheet biases against an internal surface of the blast hole within the layer of preconditioned loose rock fragments and forms a barrier preventing the internal surface of the blast hole within the preconditioned layer from falling or collapsing into the blast hole.

[0025] Preferably, the method includes forcing the flexible sheet into a conical form tapering in an axial direction from a larger diameter opening at one of the ends to a smaller diameter opening at the other end, inserting the smaller diameter end through the open end of a blast hole, and releasing the sheet to assume a substantially cylindrical form within the blast hole. In another embodiment, the method includes forcing the flexible sheet into a cylindrical form and inserting the sheet through the open end of a blast hole and releasing the sheet whereby the sheet biases against the internal surface of the blast hole.

[0026] Preferably, the method includes forcing the sheet manually into the conical or the cylindrical form. Alternatively, the method may include mechanically forcing the sheet into the conical or the cylindrical form.

[0027] Preferably, the sheet has a longitudinal length dimension that is 1 metre, 1.5 metres, 2 metres, 2.5 metres, 3 metres, 3.5 metres, 4 metres or more or any length therebetween as determined by geological requirements. Preferably, the method includes inserting the curved sheet into the open end of the blast hole whereby the curved sheet closely faces an internal surface of the blast hole down to a depth of about 1 metre, about 1.5 metres, about 2 metres, about 2.5 metres, about 3 metres, about 3.5 metres, about 4 metres or more or any depth therebetween within the layer of preconditioned loose rock fragments as determined by geological requirements.

[0028] In another aspect, the invention provides a deployment device for deploying into a blast hole an apparatus for preventing surrounding loose rock fragments from falling or collapsing into the blast hole, the device including a forming apparatus adapted to form a flat flexible sheet into a curved form for insertion into the open end of a blast hole whereby the curved sheet closely faces an internal surface of the blast hole forming a barrier preventing surrounding loose rock fragments from falling or collapsing into the blast hole.

[0029] Preferably, the forming apparatus includes a shaped passage adapted to form the sheet into the curved form as the sheet moves through the passage.

[0030] In an embodiment, the shaped passage includes a wide opening at the top and side walls tapering towards a narrower bottom outlet.

[0031] Preferably, the deployment device includes a store of a plurality of the sheets arranged in a stack. The deployment device preferably includes a sheet picker and feeder that is operable to pick an individual sheet from the stack and feed the sheet through the shaped passage.

BRIEF DESCRIPTION OF THE FIGURES

[0032] The present invention will now be described in more detail with reference to preferred embodiments illustrated in the accompanying figures, wherein:

[0033] Figure 1 illustrates a perspective view of an apparatus for preventing surrounding loose rock fragments from falling into a blast hole, wherein the apparatus includes a resiliently flexible substantially rectilinear sheet having pair of opposite substantially parallel edges;

[0034] Figure 2 illustrates a perspective view of the apparatus of figure 1 wherein the resiliently flexible sheet is forced into a conical form tapering in an axial direction from a larger diameter end to a smaller diameter end;

[0035] Figure 3 illustrates a perspective view of the apparatus of figure 1, wherein the smaller diameter end is inserted through the open end of a blast hole;

[0036] Figure 4 illustrates a perspective view of the apparatus of figure 1, wherein after the smaller diameter end is inserted through the open end of a blast hole the sheet is released to assume a substantially cylindrical form coaxial with the blast hole thereby forming a barrier preventing surrounding loose rock fragments from falling into the blast hole;

[0037] Figure 4 illustrates a front view of the apparatus of figure 1, wherein opposite substantially parallel edges of the sheet are closely spaced from each other and wherein an elongated member is inserted through horizontally aligned openings in the cylindrical apparatus for engaging a surface surrounding the blast hole to prevent further insertion of the sheet through the opening of the blast hole;

[0038] Figure 5 illustrates a top view of the apparatus of figure 1, wherein elongated flanges along the opposite parallel edges are closely spaced apart and are adapted for abutment with each other;

[0039] Figure 6 illustrates a perspective view of an apparatus in accordance with another embodiment of the invention.

[0040] Figure 7 illustrates a plan view of an embodiment of the invention including an apparatus for preventing surrounding loose rock fragments from falling or collapsing into a blast hole, wherein the apparatus includes a resiliently flexible substantially rectilinear sheet having pair of opposite substantially parallel edges wherein the edges taper at one end;

[0041] Figure 8 illustrates a perspective view of the apparatus of Figure 7 wherein the sheet is forced into a cylindrical form; and

[0042] Figure 9 illustrates an apparatus for deploying the sheet of any of the embodiments of figures 1 to 8 into the blast hole.

[0043] The invention will now be described in further detail with reference to the embodiments illustrated in the Figures.

DETAILED DESCRIPTION

[0044] Referring to Figures 1 to 5, there is shown an embodiment of the invention comprising an apparatus 10 that, in use, is adapted for preventing surrounding loose rock fragments 40 from falling or collapsing into a blast hole 30. In Figure 1 a frontal section of an open end of a single blast hole 30 is illustrated although it is to be appreciated that a multitude of such blast holes 30 would be drilled for a single blasting operation. The blast hole 30 can be drilled with a diameter as large as 270 to 311 millimetres or as much as 350 millimetres or more and to depths of as much as 50 metres or more. After drilling, the blast hole 30 is filled with explosive material appropriate for the ground conditions, such as a mixture of ammonium nitrate and fuel oil (ANFO) or an emulsion or a mixture thereof and is primed for detonation.

[0045] Most of the rock that is fragmented after a blasting operation is removed from a mine site by excavators for further processing or waste removal. However, significant quantities of loose rock fragments or

“preconditioned” rock fragments can remain on the mine bench from the sub-drilled region after achieving the Reduced Level (RL). It can be desirable to employ substantially increased sub-drill lengths to deliberately and significantly increase the depth of the preconditioned layer. A preconditioned layer depth of up to 4 metres or more can improve the efficiency of the comminution process by maximising the volume of fine fragmentation that results from the subsequent blasting operation. In the location where blast holes for a subsequent blasting operation are to be drilled these preconditioned rock fragments remain. As shown in Figure 1, the blast hole 30 comprises an open upper end 33 which is surrounded by a layer of preconditioning comprised of loose rock fragments 40. The layer of preconditioned rock fragments 40 can have a depth of up to 4 or more metres. As such, up to the first 4 or more metres of the depth of the blast hole 30 below the upper open end 33 can be through the preconditioned layer of loose rock fragments 40. A quantity of the loose rock fragments 40 can collapse into the blast hole 30 at or towards the open upper end 33 of the blast hole 30.

[0046] Figure 2 illustrates an embodiment of the apparatus 10 of the present invention. The apparatus 10 includes a flexible sheet 20, preferably comprised of a resilient material, such as a resiliently flexible polymeric material which may be reinforced with nylon or some other flexible reinforcement. The material from which the flexible sheet 20 is formed is a high-density polyethylene (HDPE) composite, which may or may not be reinforced, with anti-static properties. The sheet 20 includes a pair of opposite surfaces 18, 19 and is preferably formed in a rectangular shape such that it includes a first pair of spaced apart and longitudinally extending parallel side edges 21, 23 and a second pair of spaced apart and laterally extending parallel end edges 22, 24. In the embodiment of Figures 1 to 5 the first pair of parallel side edges 21, 23 comprise elongated flanges 25, 27 extending along substantially the entire lengths thereof. It is to be appreciated that the second pair of parallel and spaced apart end edges 22, 24 need not necessarily be parallel. The sheet 20 includes a series of apertures 12, 13, 14, 15 that are arranged in laterally spaced apart and longitudinally aligned pairs 12, 14 and 13, 15. The sheet 20

includes a further aperture 16 located adjacent to one of the end edges 16 that functions as a handle.

[0047] Figures 3 and 4 illustrate the sheet 20 in use. As shown in Figure 3, the sheet 20 is adapted to be forced from its resting flat form into a curved form, such as a cylindrical or conical form. The sheet 20 may be forced into the cylindrical or conical form by manually or mechanically bending the sheet 20. When the sheet 20 is in the cylindrical form or, as illustrated in Figure 3, the conical form the sheet 20 defines a longitudinal passage tapering in an axial direction from a larger diameter end 11 defining a larger diameter opening to a smaller diameter end 12 defining a smaller diameter opening. The larger diameter end 11 is comprised of one of the end edges 22 closest to the series of apertures 12, 13, 14, 15. The smaller diameter end 12 is comprised of the other one of the end edges 24 furthest from the series of apertures 12, 13, 14, 15. The smaller diameter end 12 has an overall diameter that is smaller than the diameter of the open end 33 of the blast hole 30. The smaller diameter end 12 of the sheet 20, when it is in the conical form, is inserted first into the open end 33 of the blast hole 30.

[0048] After the smaller diameter end 12 of the sheet 20 is inserted into the open end 33 of the blast hole 30. The sheet 20 is then released so that the resilient properties of the material from which the sheet 20 is formed allow the sheet 20 to expand and, perhaps in conjunction with some manual manipulation, assume a substantially cylindrical form substantially coaxial with the blast hole 30. As illustrated in Figures 4 and 5, one of the opposite surfaces 18 of the sheet forms a cylindrical external, outwardly facing surface that faces an inwardly facing substantially cylindrical surface 32 of the blast hole 30.

[0049] Although the figures illustrate the sheet 20 being formed into a conical shape for insertion into the blast hole 30 it is to be appreciated that the sheet 20 may be formed into a substantially cylindrical shape defining a longitudinal passage extending between the longitudinally opposite ends 11, 12 thereof. The diameters of the ends 11, 12 may be substantially the same prior to insertion of one of the ends 11, 12 into the open end 33 of the blast hole 30.

When the sheet 20 is released it may already be substantially cylindrical and coaxial with the substantially cylindrical surface 32 of the blast hole 30. The resilient properties of the material from which the sheet 20 is formed cause the external surface 18 to be biased against the internal surface 32 of the blast hole 30.

[0050] As illustrated in Figure 4, the sheet 20 locates within the open end 33 of the blast hole 30 and forms a barrier preventing surrounding loose rock fragments 40 from falling or collapsing into the blast hole 30 at or near the open end 33 of the blast hole 30. As the layer of preconditioned rock fragments 40 can have a depth of up to four or more metres the sheet 20 helps to support the upper portion of the internal surface 32 of the blast hole 30 from collapsing. The longitudinal dimension of the sheet 20 between the longitudinally opposite end edges 22, 24 may be 1 metre, 1.5 metres, 2, metres, 2.5 metres, 3 metres, 3.5 metres, 4 metres or more in length or any length in between. The length of the sheet 20 is selected based on geological requirements. When positioned within the blast hole 30 the sheet 20 provides support for the internal surface 32 through a substantial portion of the preconditioned layer of rock fragments 40. The sheet 20 thereby forms a barrier preventing surrounding loose rock fragments 40, such as within the preconditioned layer, from falling or collapsing into the blast hole 30.

[0051] The width of the sheet 20 between the pair of parallel side edges 21, 23 is slightly less than the circumference of the inwardly facing substantially cylindrical surface 32 of the blast hole 30. When the sheet 20 assumes the substantially cylindrical form within the blast hole 30 the side edges 21, 23 of the sheet are spaced apart and do not overlap. In the embodiment of Figures 1 to 5, the elongated flanges 25, 27 are spaced apart a small distance and are adapted for abutment with each other to prevent the edges 21, 23 from sliding over one another. The elongated flanges 25, 27 prevent the circumference of the sheet 20, in its cylindrical form within the blast hole 30, from decreasing below a threshold. Put another way, the elongated flanges 25, 27 along the edges of the panel 20 are adapted to come into abutment to support the cylindrical structure of the sheet 20 and, hence support the external cylindrical

surface 18 of the sheet 20 against the inwardly facing substantially cylindrical surface 32 of the blast hole 30 and loose rock fragments 40 at or near the open end 33 of the blast hole 30.

[0052] Each one of the apertures 12, 13, 14, 15 extends through the sheet 20 from the external surface 18 to the internal surface 19. An elongated rod member 50 can be inserted horizontally through a pair of the horizontally aligned apertures 12, 14 or 13, 15. Each pair of horizontally aligned apertures 12, 14, 13, 15 are located at different positions along the length of the sheet 20 so that a user can select a height of the sheet 20 within the blast hole 30. Opposite ends of the rod member 50 engage a surface 55 surrounding the open end 33 of the blast hole 30. The rod member 50 engages the pair of horizontally aligned apertures 12, 14 or 13, 15 and the surrounding surface 55 to prevent the sheet 30 from passing further into the open end 33 of the blast hole 30. As shown in Figure 4, a small portion of the sheet protrudes from the open end 33 of the blast hole 30. The elongated rod member 50 functions to anchor the sheet 20 at or towards the open end 33 of the blast hole 30.

[0053] Figure 6 illustrates another embodiment of the apparatus 100 which is like the embodiments of Figures 1 to 5 and functions in a similar fashion. Features of the apparatus of Figure 6 that are structurally or functionally like, or are the same as, features of the embodiment of Figures 1 to 5 are represented by like reference numerals. The apparatus 100 includes a flexible sheet 20, preferably comprised of a sheet of resilient material such as a resiliently flexible polymeric material That may also be reinforced. The sheet 20 includes a pair of opposite surfaces 18, 19 and is preferably formed in a rectangular shape such that it includes a first pair of spaced apart and transversely opposite and longitudinally extending parallel side edges 21, 23 and a second pair of spaced apart and longitudinally opposite and transversely extending parallel end edges 22, 24. Unlike the embodiment of Figures 1 to 5, the embodiment of Figure 6 has no elongated flanges along the first pair of parallel side edges 21, 23. It is to be appreciated that the pairs of edges 21, 23, 22, 24 need not necessarily be parallel. The sheet 20 includes a series of apertures 12, 13, 14, 15 that are arranged in laterally spaced apart and longitudinally aligned pairs 12, 14 and

13, 15. The sheet 20 includes several apertures 16 that act as handles or hand-holds allowing a user to manipulate the sheet 20 from a flat condition, as illustrated in Figure 6, into a conical or cylindrical condition as illustrated in Figures 3, 4 and 5. The apertures 16 acts as a handle allow a user to manoeuvre the sheet 20 into and out of or relative to the open end 33 of the blast hole 30.

[0054] Although in the embodiment of the apparatus 100 of Figure 6 the width of the sheet 20 between the longitudinally extending side edges 21, 23 less than the circumference of the blast hole 30 it is to be appreciated that in other embodiments the width may be equal to or greater than the circumference of the blast hole 30.

[0055] Figures 7 and 8 illustrate another embodiment of the apparatus 200 which is like the embodiments of Figure 1 to 6 and functions in a similar fashion. Features of the apparatus of Figures 7 and 8 that are similar or the same as features of the embodiment of Figures 1 to 6 are represented by like reference numerals. The apparatus 200 includes a flexible sheet 20, comprised of a sheet of resilient material such as a resiliently flexible polymeric material that is reinforced. The sheet 20 includes a pair of opposite surfaces 18, 19 and is formed in a rectangular shape such that it includes a first pair of spaced apart and transversely opposite parallel side edges 21, 23 and a second pair of spaced apart and longitudinally opposite parallel end edges 22, 24. Unlike the embodiment of Figure 6, in the embodiment of Figures 7 and 8 the transversely opposite parallel side edges 21, 23 are tapered at ends 21a, 23a thereof. The tapering of the ends 21a, 23a of the transversely opposite parallel side edges 21, 23 reduces outward flaring of the corners of the sheet 20 when the sheet 20 is forced, whether manually or otherwise, into a curved form, such as a cylindrical form as illustrated in Figure 8. Accordingly, when the sheet 20 is bent over on itself and the transversely opposite parallel edges 21, 23 are brought towards each other the tapering of the ends 21a, 23a of the transversely opposite parallel edges 21, 23 promote a more uniform cylindrical form for the sheet 20. The distal end of the sheet 20 comprising the tapered ends 21a, 23a is adapted to be inserted first into the blast hole 30. Minimising

outward flaring of the corners of the sheet 20 at the distal end thereof where the transversely opposite parallel edges 21, 23 and the longitudinally opposite parallel edges 22, 24 meet aids in ease of insertion of the sheet 20 into the blast hole 30.

[0056] In another aspect, the invention provides a method for preventing surrounding loose rock fragments 40 from falling or collapsing into the blast hole 30. The method includes a step of bending, such as by manually or otherwise forcing a resiliently flexible sheet 20, such as the sheet 20 of Figure 2 or of Figure 6, into a substantially cylindrical form or a conical form tapering in an axial direction from a larger diameter end to a smaller diameter end, such as is illustrated in Figure 3. The method includes inserting one end of the sheet 20, which may be the smaller diameter end, through the open end of a blast hole 30, such as is shown in Figure 3. The sheet 20 is then released, or may be manipulated, to assume a substantially cylindrical form coaxial with the blast hole 30 as illustrated in Figure 4. The sheet 20 thereby forms a barrier preventing surrounding loose rock fragments from falling or collapsing into the blast hole 30 at or near the open end of the blast hole 30.

[0057] In another aspect, the invention provides a bench blasting method. The method includes drilling blast holes through a layer of preconditioned loose rock fragments 40 and into the stable rock below. The preconditioned layer 40 may be up to or more than 4 metres in depth. The method includes forming a substantially flat flexible sheet 20, such as the sheet 20 of Figure 2 or of Figure 6, into a curved form defining a longitudinal passage extending between openings at longitudinally opposite ends. The method further includes inserting one end of the curved sheet 20 into an open end of the blast hole 30 whereby the curved sheet 20 closely faces an internal surface 32 of the blast hole 30 within the layer of preconditioned loose rock fragments 40 and forms a barrier preventing the internal surface 32 of the blast hole 30 within the preconditioned layer of loose rock fragments 40 from falling or collapsing into the blast hole 30.

[0058] The methods can include forcing the flexible sheet 20 into a conical form tapering in an axial direction from a larger diameter opening at one of the

ends to a smaller diameter opening at the other end, inserting the smaller diameter end through the open end of a blast hole 30, and releasing the sheet 20 to assume a substantially cylindrical form within the blast hole 30. Alternatively, the method can involve forcing the flexible sheet 20 into a substantially cylindrical form and inserting one end through the open end of the blast hole 30 down to a desired depth. An elongated rod 50 can then be inserted through apertures 12, 14, 13, 15 within the sheet 20. The elongated rod 50 engages the surface surrounding the blast hole 30, as illustrated in Figure 3, to maintain the sheet 20 at the opening into the blast hole.

[0059] Preferably, the sheet 20 has a longitudinal length dimension that is 1 metre, 1.5 metres, 2 metres, 2.5 metres, 3 metres, 3.5 metres, 4 metres or more or any length therebetween. The length of the sheet 20 is selected based on geological requirements. Preferably, the methods include inserting the curved sheet 20 into the open end of the blast hole 30 whereby the curved sheet 20 closely faces an internal surface 32 of the blast hole 30 down to a depth of about 1 metre, about 1.5 metres, about 2 metres, about 2.5 metres, about 3 metres, about 3.5 metres, about 4 metres or more or any depth therebetween within the layer of preconditioned loose rock fragments 40.

[0060] The sheet 20 may remain in position within the blast hole 30 during a subsequent step of depositing explosives and other consumables into the blast hole 30. In embodiments of the methods, the sheet 20 may remain in the cylindrical form or may be manipulated into a conical form, such as by bending the sheet 20 into the conical form, as illustrated in Figure 3, such that the sheet 20 may operate as a funnel through which explosives and other consumables may be deposited into the blast hole 30.

[0061] In embodiments of the methods, the user selects a desired height for the sheet 20 that is located within the blast hole 30 by locating the elongated rod member 50 through a desired pair of apertures 12, 14, 13, 15. After the sheet 20 is inserted into the blast hole 30 the elongated rod member 50 rests on the surface 55 surrounding the blast hole 30. The apertures 12, 14, 13, 15 are positioned such that upon insertion of the elongated rod 50 therethrough,

the elongated rod 50 is offset from the central axis of the longitudinal passage extending through the curved sheet 20 to facilitate insertion into the blast hole 30 of lining material, loading with explosive, priming and providing any other consumables into the blast hole 30. The sheet 20 can then be partially withdrawn and formed into a funnel shape prior to depositing of stemming material into the blast hole 30. The sheet 20 may be removed from the blast hole 30 to assume a flat form for storage.

[0062] Figure 9 illustrates a deployment device 300 for deploying the sheet 20 into the blast hole 30. The device 300 includes a forming apparatus 310 adapted to form the flat flexible sheet 20 into a curved form for insertion into the open end of the blast hole 30 whereby the curved sheet closely faces the internal surface of the blast hole 30 and forms a barrier preventing surrounding loose rock fragments from falling or collapsing into the blast hole 30.

[0063] The deployment device 300 includes a plurality of the sheets 20 of Figure 6 arranged in a stack 315. The device 300 includes a sheet picker 320 and feeder 325 that is operable to pick an individual sheet 20 from the stack 315 and feed the sheet 20 to a vertical forming apparatus 330. In the embodiment illustrated in Figure 9, the picker 320 and the feeder 325 are comprised of an arrangement of driven belts operable to pick one of the sheets 20 at a time from the stack 315. However, any mechanical arrangement that is adapted to pick one sheet 20 from the stack 315 and feed the sheet 20 to the vertical forming apparatus 330 may constitute another embodiment of the invention. The forming apparatus 330 is operable to form the sheet 20 into a curved form defining a longitudinal passage extending between openings at longitudinally opposite ends. The forming apparatus 330 includes a vertically oriented shaped passage 332 with a wide opening at the top 334 and side walls tapering towards a narrower bottom outlet 336. However, any mechanical arrangement that is adapted to form the sheet 20 into a curved form defining a longitudinal passage extending between openings at longitudinally opposite ends may constitute another embodiment of the invention.

[0064] The outlet 336 of the forming apparatus 330 is adapted to be manually or automatically located over or to some extent into the open end of a blast hole 30. The sheet picker 320 and feeder 325 are operable to drive the individually picked sheet 20 through the passage 332 and through the outlet to thereby feed the curved sheet 20 into the open end of a blast hole 30. The forming apparatus 330 is operable to continue feeding the sheet 20 to a desired depth within the blast hole 30 and releases the sheet 20 when it has reached a predetermined depth. The released sheet 20, which has a substantially cylindrical form coaxial with the blast hole 30 as in Figure 4, thereby forms a barrier preventing surrounding loose rock fragments from falling or collapsing into the blast hole 30.

[0065] The deployment device 300 may be mounted to a vehicle (not shown) or a trailer (not shown) coupled to a vehicle or any other mobile apparatus adapted to be manoeuvred around a site comprising a plurality of blasting holes 30 that have previously been drilled. The vehicle or other mobile apparatus may be a truck that is operable manually by a driver or in an embodiment is configured to operate autonomously or semi-autonomously. The vehicle or other mobile apparatus may comprise a control module that includes a GPS location device and is adapted for controlling a drive means and steering means of the vehicle. The control module is adapted to receive or be programmed with the coordinates of the location of one or more of a plurality of blast holes and to autonomously manoeuvre the deployment device 300 to a location adjacent a first one of the blast holes.

[0066] When located adjacent the first blast hole 30, the control module may autonomously operate the deployment device 300 to deploy one of the sheets 20 into the blast hole 30. The control module may cause the outlet of the deployment device 300 to locate over the blast hole using the coordinates of the blast hole or using imagery from a camera mounted to the device 300 or the vehicle 350 or a combination of both. The control module may autonomously or semi-autonomously activate the sheet picker 320 and feeder 325 to drive the sheet 20 through the forming apparatus 330 and through the

outlet 336 to thereby feed the curved sheet 20 into the open end of a blast hole 30.

[0067] The control module may cause the deployment device 300, vehicle, trailer or other mobile apparatus to autonomously manoeuvre to a location adjacent the next blast hole for subsequent autonomous or semi-autonomous sheet 20 deployment. The control module may cause the platform to autonomously or semi-autonomously carry out sheet deployment across an array of blast holes.

[0068] Although the disclosure has been described with reference to specific examples, it will be appreciated by those skilled in the art that the disclosure may be embodied in many other forms, in keeping with the broad principles and the spirit of the disclosure described herein.

Claims:

1. An apparatus for preventing surrounding loose rock fragments from falling or collapsing into a blast hole, the apparatus including:

a resiliently flexible sheet including a pair of spaced apart longitudinally extending side edges and a pair of spaced apart laterally extending end edges, the sheet having a curved form defining a longitudinal passage extending between openings at longitudinally opposite ends, one end of the curved sheet being insertable into the open end of a blast hole, wherein in the curved form the side edges of the sheet are free and the sheet biases towards a flat form whereby an external surface of the curved sheet is biased against an internal surface of the blast hole and forms a barrier preventing surrounding loose rock fragments from falling or collapsing into the open end of the blast hole.

2. The apparatus of claim 1, wherein the sheet is adapted to be forced into a cylindrical or a conical form, wherein upon insertion through the open end of a blast hole the sheet assumes a substantially cylindrical form coaxially within the blast hole.

3. The apparatus of claim 1 or claim 2, wherein the width of the sheet between the longitudinally extending side edges is less than the circumference of the blast hole, equal to the circumference of the blast hole or greater than the circumference of the blast hole.

4. The apparatus of any one of claims 1 to 3, wherein the longitudinally extending side edges taper at an end thereof to promote a more uniform cylindrical form of the sheet.

5. The apparatus of any one of claims 1 to 4, wherein the sheet is comprised of a normally flat sheet of flexible material.

6. The apparatus of any one of claims 1 to 5, wherein the sheet includes apertures that are adapted to receive therethrough an elongated member for engaging a surface surrounding the blast hole to prevent further insertion of the sheet through the opening of the blast hole.

7. The apparatus of any one of claims 1 to 6, wherein the sheet includes at least one opening through the sheet adjacent to each longitudinally extending side edge operable as a hand hold for a user to manually roll the sheet into the curved form.

8. The apparatus of any one of claims 1 to 7, wherein the sheet includes at least one opening through the sheet adjacent to one of the end edges operable as a hand hold for a user to manually insert and remove the sheet relative to the open end of a blast hole.

9. A method for preventing surrounding loose rock fragments from falling into a blast hole, the method including:

providing a resiliently flexible sheet including a pair of spaced apart longitudinally extending side edges and a pair of spaced apart laterally extending end edges, forming the sheet into a curved form defining a longitudinal passage extending between openings at longitudinally opposite ends,

inserting one end of the curved sheet into the open end of a blast hole wherein in the curved form the side edges of the sheet are free and the sheet biases towards a flat form whereby an external surface of the curved sheet biases against an internal surface of the blast hole substantially coaxially therewith forming a barrier preventing surrounding loose rock fragments from falling or collapsing into the blast hole.

10. The method of claim 9, further including:

forcing the flexible sheet into a cylindrical or a conical form,

inserting one end through the open end of a blast hole, and

releasing the sheet to assume a substantially cylindrical form coaxial with the blast hole to form a barrier preventing surrounding loose rock fragments from falling into the open end of the blast hole.

11. The method of claim 9 or claim 10, including inserting an elongated member through apertures in the sheet whereby the elongated member

engages a surface surrounding the blast hole to prevent further insertion of the sheet through the open end of the blast hole

12. A bench blasting method including:

drilling blast holes through a layer of preconditioned loose rock fragments and into the stable rock below;

forming a substantially flat resiliently flexible sheet into a curved form defining a longitudinal passage extending between openings at longitudinally opposite ends;

inserting one end of the curved sheet into an open end of the blast hole wherein in the curved form the side edges of the sheet are free and the resilient sheet biases towards a flat form whereby an external surface of the curved sheet biases against an internal surface of the blast hole within the layer of preconditioned loose rock fragments forming a barrier preventing the internal surface of the blast hole within the preconditioned layer from falling or collapsing into the blast hole.

13. The method of claim 12 including: forcing the flexible sheet into a cylindrical or conical form; inserting the sheet through the open end of a blast hole; and releasing the sheet to assume a substantially cylindrical form within the blast hole.

14. The method of claim 12 or claim 13, wherein the sheet has a longitudinal length dimension that is 1 metre, 1.5 metres, 2 metres, 2.5 metres or any length therebetween.

15. The method of any one of claims 12 to 14, wherein the curved sheet is inserted into the open end of the blast hole whereby the curved sheet closely faces an internal surface of the blast hole down to a depth of about 1 metre, about 1.5 metres, about 2 metres, about 2.5 metres or any depth therebetween within the layer of preconditioned loose rock fragments.

16. A deployment device for deploying into a blast hole an apparatus for preventing surrounding loose rock fragments from falling or collapsing into the blast hole, the device including a forming apparatus adapted to form a flat

flexible sheet into a curved form for insertion into the open end of a blast hole whereby the curved sheet closely faces an internal surface of the blast hole forming a barrier preventing surrounding loose rock fragments from falling or collapsing into the blast hole.

17. The device of claim 16, wherein the forming apparatus includes a shaped passage adapted to form the sheet into the curved form as the sheet moves through the passage.

18. The device of claim 17, wherein the shaped passage includes a wide opening at the top and side walls tapering towards a narrower bottom outlet.

19. The device of any one of claims 16 to 18, wherein the deployment device includes a store of a plurality of the sheets arranged in a stack.

20. The device of claim 19, including a sheet picker and feeder is operable to pick an individual sheet from the stack and feed the sheet through the shaped passage.

A METHOD AND APPARATUS FOR PREVENTING ROCK FRAGMENTS FROM ENTERING OR COLLAPSING INTO A BLAST HOLE

TECHNICAL FIELD

[001] The present invention relates to the field of blasting, particularly in the fields of mining and quarrying.

BACKGROUND

[002] Minerals such as iron ore and coal can be recovered in a variety of methods including above ground open cut mining methods. Such methods can involve the use of blasting with bulk explosives to dislodge bulk quantities of ore for excavation and recovery through subsequent handling via excavators and the like. The blasting process results in the comminution of rock containing the ore into particles of varying sizes. It is desirable for the blasting process to produce material with an average particle size that is as small as possible to minimise the need for further comminution by crushing, grinding, vibrating and other processes.

[003] Bench blasting is a process that involves drilling holes into rock at depths, in diameters, and at spacing and filling the holes with explosive material to form a column charge that fractures the rock in a controlled manner. The blasting holes can have diameters as large as 270 to 311 or even up to 350 millimetres and larger and have depths of as much as 50 metres or more. These blast holes are filled with bulk explosive materials that are, at least in part, ammonium nitrate based low velocity explosives. The explosive material will be contacted with a primer and covered or “stemmed” with material such as aggregate. The primer is activated electrically or non-electrically to cause the explosive to detonate.

[004] Most of the rock that is fractured after a blasting operation is removed from the site by excavators for further processing or waste removal. However, significant quantities of loose rock fragments, or “preconditioned” material, can remain on the bench from the sub-drilled region after achieving the Reduced

Level (RL). It can be desirable to employ substantially increased sub-drill lengths to deliberately and significantly increase the depth of the preconditioned layer. A preconditioned layer depth of up to 4 metres or more can improve the efficiency of the comminution process by maximising the volume of fine fragmentation that results from the subsequent blasting operation.

[005] In the location where blast holes for a subsequent blasting operation are to be drilled these fragments or 'preconditioned' material remain. After blast holes have been drilled loose rock fragments or preconditioned material can collapse into the openings of completed blast holes to partially fill or even block the drill hole prior to depositing explosive material. Where up to the first four or more metres of the depth of the blast hole can be through the preconditioned layer the risk of material collapsing into blast holes can be acute. Wet environments may also lubricate the loose rock fragments, exacerbating the collapsing of loose rock fragments into the blast holes.

[006] Any discussion of background art throughout the specification should in no way be considered as an admission that any of the documents or other material referred to was published, known or forms part of the common general knowledge.

SUMMARY OF THE INVENTION

[007] Accordingly, in one aspect, the invention provides an apparatus for preventing surrounding loose rock fragments from falling or collapsing into a blast hole, the apparatus including: a resiliently flexible sheet including a pair of spaced apart longitudinally extending side edges and a pair of spaced apart laterally extending end edges, the sheet having a curved form defining a longitudinal passage extending between openings at longitudinally opposite ends, one end of the curved sheet being insertable into the open end of a blast hole, wherein in the curved form the side edges of the sheet are free and the sheet biases towards a flat form whereby an external surface of the curved sheet is biased against ~~closely faces~~ an internal surface of the blast hole and forms a barrier preventing surrounding loose rock fragments from falling or collapsing into the blast hole.

[008] Preferably, the sheet is adapted to be forced into a substantially cylindrical or a conical form wherein upon insertion through the open end of a blast hole the sheet assumes a substantially cylindrical form coaxially within the blast hole. Preferably, the sheet is adapted to be manipulated manually into the cylindrical or the conical form.

[009] In accordance with the invention Preferably, the sheet is formed of resiliently flexible material biased towards a substantially flat form whereby in use within the blast hole the sheet biases against the internal surface of the blast hole. Advantageously, the resilient properties of the material from which the sheet is formed cause the external surface of the sheet to be biased against the internal surface of the blast hole thereby forming a barrier preventing surrounding loose rock fragments from falling or collapsing into the blast hole.

[0010] In embodiments, the longitudinally extending side edges taper at an end thereof. When the sheet is bent over on itself, manually or otherwise, and the transversely opposite parallel edges are brought towards each other the tapering of the ends of the side edges to promote a more uniform cylindrical form of the sheet.

[0011] In embodiments, the width of the sheet between the longitudinally extending side edges is less than the circumference of the blast hole. Preferably, the sheet is adapted to assume a substantially cylindrical form within the blast hole wherein the side edges of the sheet are spaced apart. Preferably, the sheet is adapted to be forced, such as by being manually manipulated, into the cylindrical form. Alternatively, the sheet may be mechanically manipulated into the cylindrical form. In embodiments, the width of the sheet between the longitudinally extending side edges is equal to the circumference of the blast hole or is greater than the circumference of the blast hole. It is to be appreciated that a width less than the circumference of the blast hole is preferred as this allows for distortion and non-uniformity of the blast hole and also requires fewer openings in the sheet for use as hand holds thus minimising any weakening of the sheet. However, the embodiments of the sheet where the width of the sheet is equal to or greater than the circumference

of the blast hole also fulfils the broad objectives of the invention which is to form a barrier preventing surrounding loose rock fragments from falling or collapsing into the blast hole.

[0012] In embodiments, the longitudinally extending side edges taper at an end thereof. When the sheet is bent over on itself and the transversely opposite parallel edges are brought towards each other the tapering of the ends of the side edges promotes a more uniform cylindrical form for the sheet.

[0013] Preferably, the longitudinally extending side edges each include elongated flanges adapted for abutment with each other when the sheet is in the curved form.

[0014] In embodiments, the flexible sheet is comprised of a substantially flat sheet of flexible material. The flexible sheet has a normally flat form and is adapted to be rolled into the curved form. That is, in the resting state, the sheet will tend towards a substantially flat form.

[0015] In embodiments, the sheet includes at least one opening through the sheet adjacent to each longitudinally extending side edge operable as a hand hold for a user to manually roll the sheet into the curved form. In embodiments, the sheet includes at least one opening through the sheet adjacent to one of the end edges operable as a hand hold for a user to manually insert and remove the sheet relative to the open end of a blast hole.

[0016] In embodiments, the sheet includes a pair of openings through the sheet that are adapted to receive therethrough an elongated member for engaging a surface surrounding the blast hole to prevent further insertion of the panel through the opening of the blast hole. Preferably, the pair of openings are located adjacent to each longitudinally extending side edge and are aligned with each other along the length of the sheet for receiving the longitudinal member therethrough perpendicularly to the length of the sheet.

[0017] In another aspect, the invention provides a method for preventing surrounding loose rock fragments from falling or collapsing into a blast hole, the method including: providing a resiliently flexible sheet including a pair of spaced apart longitudinally extending side edges and a pair of spaced apart laterally extending end edges, forming the sheet into a curved form defining a longitudinal passage extending between openings at longitudinally opposite ends, inserting one end of the curved sheet into the open end of a blast hole wherein in the curved form the side edges of the sheet are free and the sheet biases towards a flat form whereby an external surface of the curved sheet biases against~~closely faces~~ an internal surface of the blast hole and substantially coaxially therewith forming a barrier preventing surrounding loose rock fragments from falling or collapsing into the blast hole.

[0018] Preferably, the method includes locating the sheet within the blast hole within a layer of preconditioned loose rock fragments to form a barrier preventing the internal surface of the blast hole within the preconditioned layer from falling or collapsing into the blast hole. Preferably, the method can include inserting an elongated member through apertures in the sheet whereby the elongated member engages a surface surrounding the blast hole to prevent further insertion of the sheet through the open end of the blast hole.

[0019] In an embodiment, the method includes: forcing the flexible sheet into a conical form tapering in an axial direction from a larger diameter opening at one of the ends to a smaller diameter opening at the other end, inserting the smaller diameter end through the open end of a blast hole, and releasing the sheet to assume a substantially cylindrical form within the blast hole thereby forming a barrier preventing surrounding loose rock fragments from falling or collapsing into the blast hole.

[0020] In another embodiment, the method includes: forcing the flexible sheet into a cylindrical form and inserting the sheet through the open end of a blast hole and releasing the sheet whereby the sheet biases against the internal surface of the blast hole forming a barrier preventing surrounding loose rock fragments from falling or collapsing into the blast hole.

[0021] Preferably, the method includes forcing the sheet manually into the conical or the cylindrical form. Alternatively, the method may include mechanically forcing the sheet into the conical or the cylindrical form.

[0022] Embodiments of the apparatus and method are advantageous in that they provide convenient installation of a barrier in the open end of a blast hole that prevents surrounding loose rock fragments from falling or collapsing into the blast hole.

[0023] Embodiments of the apparatus and method are advantageous in that they operate to maintain an open collar for the blast hole to enable ease in depositing typical explosives and other consumables into the blast hole.

[0024] In another aspect, the invention provides a bench blasting method including: drilling blast holes through a layer of preconditioned loose rock fragments and into the stable rock below; forming a substantially flat resiliently flexible sheet into a curved form defining a longitudinal passage and openings at longitudinally opposite ends, inserting one end of the curved sheet into an open end of the blast hole wherein in the curved form the side edges of the sheet are free and the resilient sheet biases towards a flat form whereby in an external surface of the curved sheet biases against~~closely faces~~ an internal surface of the blast hole within the layer of preconditioned loose rock fragments and forms a barrier preventing the internal surface of the blast hole within the preconditioned layer from falling or collapsing into the blast hole.

[0025] Preferably, the method includes forcing the flexible sheet into a conical form tapering in an axial direction from a larger diameter opening at one of the ends to a smaller diameter opening at the other end, inserting the smaller diameter end through the open end of a blast hole, and releasing the sheet to assume a substantially cylindrical form within the blast hole. In another embodiment, the method includes forcing the flexible sheet into a cylindrical form and inserting the sheet through the open end of a blast hole and releasing the sheet whereby the sheet biases against the internal surface of the blast hole.

[0026] Preferably, the method includes forcing the sheet manually into the conical or the cylindrical form. Alternatively, the method may include mechanically forcing the sheet into the conical or the cylindrical form.

[0027] Preferably, the sheet has a longitudinal length dimension that is 1 metre, 1.5 metres, 2 metres, 2.5 metres, 3 metres, 3.5 metres, 4 metres or more or any length therebetween as determined by geological requirements. Preferably, the method includes inserting the curved sheet into the open end of the blast hole whereby the curved sheet closely faces an internal surface of the blast hole down to a depth of about 1 metre, about 1.5 metres, about 2 metres, about 2.5 metres, about 3 metres, about 3.5 metres, about 4 metres or more or any depth therebetween within the layer of preconditioned loose rock fragments as determined by geological requirements.

[0028] In another aspect, the invention provides a deployment device for deploying into a blast hole an apparatus for preventing surrounding loose rock fragments from falling or collapsing into the blast hole, the device including a forming apparatus adapted to form a flat flexible sheet into a curved form for insertion into the open end of a blast hole whereby the curved sheet closely faces an internal surface of the blast hole forming a barrier preventing surrounding loose rock fragments from falling or collapsing into the blast hole.

[0029] Preferably, the forming apparatus includes a shaped passage adapted to form the sheet into the curved form as the sheet moves through the passage.

[0030] In an embodiment, the shaped passage includes a wide opening at the top and side walls tapering towards a narrower bottom outlet.

[0031] Preferably, the deployment device includes a store of a plurality of the sheets arranged in a stack. The deployment device preferably includes a sheet picker and feeder that is operable to pick an individual sheet from the stack and feed the sheet through the shaped passage.

BRIEF DESCRIPTION OF THE FIGURES

[0032] The present invention will now be described in more detail with reference to preferred embodiments illustrated in the accompanying figures, wherein:

[0033] Figure 1 illustrates a perspective view of an apparatus for preventing surrounding loose rock fragments from falling into a blast hole, wherein the apparatus includes a resiliently flexible substantially rectilinear sheet having pair of opposite substantially parallel edges;

[0034] Figure 2 illustrates a perspective view of the apparatus of figure 1 wherein the resiliently flexible sheet is forced into a conical form tapering in an axial direction from a larger diameter end to a smaller diameter end;

[0035] Figure 3 illustrates a perspective view of the apparatus of figure 1, wherein the smaller diameter end is inserted through the open end of a blast hole;

[0036] Figure 4 illustrates a perspective view of the apparatus of figure 1, wherein after the smaller diameter end is inserted through the open end of a blast hole the sheet is released to assume a substantially cylindrical form coaxial with the blast hole thereby forming a barrier preventing surrounding loose rock fragments from falling into the blast hole;

[0037] Figure 4 illustrates a front view of the apparatus of figure 1, wherein opposite substantially parallel edges of the sheet are closely spaced from each other and wherein an elongated member is inserted through horizontally aligned openings in the cylindrical apparatus for engaging a surface surrounding the blast hole to prevent further insertion of the sheet through the opening of the blast hole;

[0038] Figure 5 illustrates a top view of the apparatus of figure 1, wherein elongated flanges along the opposite parallel edges are closely spaced apart and are adapted for abutment with each other;

[0039] Figure 6 illustrates a perspective view of an apparatus in accordance with another embodiment of the invention.

[0040] Figure 7 illustrates a plan view of an embodiment of the invention including an apparatus for preventing surrounding loose rock fragments from falling or collapsing into a blast hole, wherein the apparatus includes a resiliently flexible substantially rectilinear sheet having pair of opposite substantially parallel edges wherein the edges taper at one end;

[0041] Figure 8 illustrates a perspective view of the apparatus of Figure 7 wherein the sheet is forced into a cylindrical form; and

[0042] Figure 9 illustrates an apparatus for deploying the sheet of any of the embodiments of figures 1 to 8 into the blast hole.

[0043] The invention will now be described in further detail with reference to the embodiments illustrated in the Figures.

DETAILED DESCRIPTION

[0044] Referring to Figures 1 to 5, there is shown an embodiment of the invention comprising an apparatus 10 that, in use, is adapted for preventing surrounding loose rock fragments 40 from falling or collapsing into a blast hole 30. In Figure 1 a frontal section of an open end of a single blast hole 30 is illustrated although it is to be appreciated that a multitude of such blast holes 30 would be drilled for a single blasting operation. The blast hole 30 can be drilled with a diameter as large as 270 to 311 millimetres or as much as 350 millimetres or more and to depths of as much as 50 metres or more. After drilling, the blast hole 30 is filled with explosive material appropriate for the ground conditions, such as a mixture of ammonium nitrate and fuel oil (ANFO) or an emulsion or a mixture thereof and is primed for detonation.

[0045] Most of the rock that is fragmented after a blasting operation is removed from a mine site by excavators for further processing or waste removal. However, significant quantities of loose rock fragments or

“preconditioned” rock fragments can remain on the mine bench from the sub-drilled region after achieving the Reduced Level (RL). It can be desirable to employ substantially increased sub-drill lengths to deliberately and significantly increase the depth of the preconditioned layer. A preconditioned layer depth of up to 4 metres or more can improve the efficiency of the comminution process by maximising the volume of fine fragmentation that results from the subsequent blasting operation. In the location where blast holes for a subsequent blasting operation are to be drilled these preconditioned rock fragments remain. As shown in Figure 1, the blast hole 30 comprises an open upper end 33 which is surrounded by a layer of preconditioning comprised of loose rock fragments 40. The layer of preconditioned rock fragments 40 can have a depth of up to 4 or more metres. As such, up to the first 4 or more metres of the depth of the blast hole 30 below the upper open end 33 can be through the preconditioned layer of loose rock fragments 40. A quantity of the loose rock fragments 40 can collapse into the blast hole 30 at or towards the open upper end 33 of the blast hole 30.

[0046] Figure 2 illustrates an embodiment of the apparatus 10 of the present invention. The apparatus 10 includes a flexible sheet 20, preferably comprised of a resilient material, such as a resiliently flexible polymeric material which may be reinforced with nylon or some other flexible reinforcement. The material from which the flexible sheet 20 is formed is a high-density polyethylene (HDPE) composite, which may or may not be reinforced, with anti-static properties. The sheet 20 includes a pair of opposite surfaces 18, 19 and is preferably formed in a rectangular shape such that it includes a first pair of spaced apart and longitudinally extending parallel side edges 21, 23 and a second pair of spaced apart and laterally extending parallel end edges 22, 24. In the embodiment of Figures 1 to 5 the first pair of parallel side edges 21, 23 comprise elongated flanges 25, 27 extending along substantially the entire lengths thereof. It is to be appreciated that the second pair of parallel and spaced apart end edges 22, 24 need not necessarily be parallel. The sheet 20 includes a series of apertures 12, 13, 14, 15 that are arranged in laterally spaced apart and longitudinally aligned pairs 12, 14 and 13, 15. The sheet 20

includes a further aperture 16 located adjacent to one of the end edges 16 that functions as a handle.

[0047] Figures 3 and 4 illustrate the sheet 20 in use. As shown in Figure 3, the sheet 20 is adapted to be forced from its resting flat form into a curved form, such as a cylindrical or conical form. The sheet 20 may be forced into the cylindrical or conical form by manually or mechanically bending the sheet 20. When the sheet 20 is in the cylindrical form or, as illustrated in Figure 3, the conical form the sheet 20 defines a longitudinal passage tapering in an axial direction from a larger diameter end 11 defining a larger diameter opening to a smaller diameter end 12 defining a smaller diameter opening. The larger diameter end 11 is comprised of one of the end edges 22 closest to the series of apertures 12, 13, 14, 15. The smaller diameter end 12 is comprised of the other one of the end edges 24 furthest from the series of apertures 12, 13, 14, 15. The smaller diameter end 12 has an overall diameter that is smaller than the diameter of the open end 33 of the blast hole 30. The smaller diameter end 12 of the sheet 20, when it is in the conical form, is inserted first into the open end 33 of the blast hole 30.

[0048] After the smaller diameter end 12 of the sheet 20 is inserted into the open end 33 of the blast hole 30. The sheet 20 is then released so that the resilient properties of the material from which the sheet 20 is formed allow the sheet 20 to expand and, perhaps in conjunction with some manual manipulation, assume a substantially cylindrical form substantially coaxial with the blast hole 30. As illustrated in Figures 4 and 5, one of the opposite surfaces 18 of the sheet forms a cylindrical external, outwardly facing surface that faces an inwardly facing substantially cylindrical surface 32 of the blast hole 30.

[0049] Although the figures illustrate the sheet 20 being formed into a conical shape for insertion into the blast hole 30 it is to be appreciated that the sheet 20 may be formed into a substantially cylindrical shape defining a longitudinal passage extending between the longitudinally opposite ends 11, 12 thereof. The diameters of the ends 11, 12 may be substantially the same prior to insertion of one of the ends 11, 12 into the open end 33 of the blast hole 30.

When the sheet 20 is released it may already be substantially cylindrical and coaxial with the substantially cylindrical surface 32 of the blast hole 30. The resilient properties of the material from which the sheet 20 is formed cause the external surface 18 to be biased against the internal surface 32 of the blast hole 30.

[0050] As illustrated in Figure 4, the sheet 20 locates within the open end 33 of the blast hole 30 and forms a barrier preventing surrounding loose rock fragments 40 from falling or collapsing into the blast hole 30 at or near the open end 33 of the blast hole 30. As the layer of preconditioned rock fragments 40 can have a depth of up to four or more metres the sheet 20 helps to support the upper portion of the internal surface 32 of the blast hole 30 from collapsing. The longitudinal dimension of the sheet 20 between the longitudinally opposite end edges 22, 24 may be 1 metre, 1.5 metres, 2, metres, 2.5 metres, 3 metres, 3.5 metres, 4 metres or more in length or any length in between. The length of the sheet 20 is selected based on geological requirements. When positioned within the blast hole 30 the sheet 20 provides support for the internal surface 32 through a substantial portion of the preconditioned layer of rock fragments 40. The sheet 20 thereby forms a barrier preventing surrounding loose rock fragments 40, such as within the preconditioned layer, from falling or collapsing into the blast hole 30.

[0051] The width of the sheet 20 between the pair of parallel side edges 21, 23 is slightly less than the circumference of the inwardly facing substantially cylindrical surface 32 of the blast hole 30. When the sheet 20 assumes the substantially cylindrical form within the blast hole 30 the side edges 21, 23 of the sheet are spaced apart and do not overlap. In the embodiment of Figures 1 to 5, the elongated flanges 25, 27 are spaced apart a small distance and are adapted for abutment with each other to prevent the edges 21, 23 from sliding over one another. The elongated flanges 25, 27 prevent the circumference of the sheet 20, in its cylindrical form within the blast hole 30, from decreasing below a threshold. Put another way, the elongated flanges 25, 27 along the edges of the panel 20 are adapted to come into abutment to support the cylindrical structure of the sheet 20 and, hence support the external cylindrical

surface 18 of the sheet 20 against the inwardly facing substantially cylindrical surface 32 of the blast hole 30 and loose rock fragments 40 at or near the open end 33 of the blast hole 30.

[0052] Each one of the apertures 12, 13, 14, 15 extends through the sheet 20 from the external surface 18 to the internal surface 19. An elongated rod member 50 can be inserted horizontally through a pair of the horizontally aligned apertures 12, 14 or 13, 15. Each pair of horizontally aligned apertures 12, 14, 13, 15 are located at different positions along the length of the sheet 20 so that a user can select a height of the sheet 20 within the blast hole 30. Opposite ends of the rod member 50 engage a surface 55 surrounding the open end 33 of the blast hole 30. The rod member 50 engages the pair of horizontally aligned apertures 12, 14 or 13, 15 and the surrounding surface 55 to prevent the sheet 30 from passing further into the open end 33 of the blast hole 30. As shown in Figure 4, a small portion of the sheet protrudes from the open end 33 of the blast hole 30. The elongated rod member 50 functions to anchor the sheet 20 at or towards the open end 33 of the blast hole 30.

[0053] Figure 6 illustrates another embodiment of the apparatus 100 which is like the embodiments of Figures 1 to 5 and functions in a similar fashion. Features of the apparatus of Figure 6 that are structurally or functionally like, or are the same as, features of the embodiment of Figures 1 to 5 are represented by like reference numerals. The apparatus 100 includes a flexible sheet 20, preferably comprised of a sheet of resilient material such as a resiliently flexible polymeric material That may also be reinforced. The sheet 20 includes a pair of opposite surfaces 18, 19 and is preferably formed in a rectangular shape such that it includes a first pair of spaced apart and transversely opposite and longitudinally extending parallel side edges 21, 23 and a second pair of spaced apart and longitudinally opposite and transversely extending parallel end edges 22, 24. Unlike the embodiment of Figures 1 to 5, the embodiment of Figure 6 has no elongated flanges along the first pair of parallel side edges 21, 23. It is to be appreciated that the pairs of edges 21, 23, 22, 24 need not necessarily be parallel. The sheet 20 includes a series of apertures 12, 13, 14, 15 that are arranged in laterally spaced apart and longitudinally aligned pairs 12, 14 and

13, 15. The sheet 20 includes several apertures 16 that act as handles or hand-holds allowing a user to manipulate the sheet 20 from a flat condition, as illustrated in Figure 6, into a conical or cylindrical condition as illustrated in Figures 3, 4 and 5. The apertures 16 acts as a handle allow a user to manoeuvre the sheet 20 into and out of or relative to the open end 33 of the blast hole 30.

[0054] Although in the embodiment of the apparatus 100 of Figure 6 the width of the sheet 20 between the longitudinally extending side edges 21, 23 less than the circumference of the blast hole 30 it is to be appreciated that in other embodiments the width may be equal to or greater than the circumference of the blast hole 30.

[0055] Figures 7 and 8 illustrate another embodiment of the apparatus 200 which is like the embodiments of Figure 1 to 6 and functions in a similar fashion. Features of the apparatus of Figures 7 and 8 that are similar or the same as features of the embodiment of Figures 1 to 6 are represented by like reference numerals. The apparatus 200 includes a flexible sheet 20, comprised of a sheet of resilient material such as a resiliently flexible polymeric material that is reinforced. The sheet 20 includes a pair of opposite surfaces 18, 19 and is formed in a rectangular shape such that it includes a first pair of spaced apart and transversely opposite parallel side edges 21, 23 and a second pair of spaced apart and longitudinally opposite parallel end edges 22, 24. Unlike the embodiment of Figure 6, in the embodiment of Figures 7 and 8 the transversely opposite parallel side edges 21, 23 are tapered at ends 21a, 23a thereof. The tapering of the ends 21a, 23a of the transversely opposite parallel side edges 21, 23 reduces outward flaring of the corners of the sheet 20 when the sheet 20 is forced, whether manually or otherwise, into a curved form, such as a cylindrical form as illustrated in Figure 8. Accordingly, when the sheet 20 is bent over on itself and the transversely opposite parallel edges 21, 23 are brought towards each other the tapering of the ends 21a, 23a of the transversely opposite parallel edges 21, 23 promote a more uniform cylindrical form for the sheet 20. The distal end of the sheet 20 comprising the tapered ends 21a, 23a is adapted to be inserted first into the blast hole 30. Minimising

outward flaring of the corners of the sheet 20 at the distal end thereof where the transversely opposite parallel edges 21, 23 and the longitudinally opposite parallel edges 22, 24 meet aids in ease of insertion of the sheet 20 into the blast hole 30.

[0056] In another aspect, the invention provides a method for preventing surrounding loose rock fragments 40 from falling or collapsing into the blast hole 30. The method includes a step of bending, such as by manually or otherwise forcing a resiliently flexible sheet 20, such as the sheet 20 of Figure 2 or of Figure 6, into a substantially cylindrical form or a conical form tapering in an axial direction from a larger diameter end to a smaller diameter end, such as is illustrated in Figure 3. The method includes inserting one end of the sheet 20, which may be the smaller diameter end, through the open end of a blast hole 30, such as is shown in Figure 3. The sheet 20 is then released, or may be manipulated, to assume a substantially cylindrical form coaxial with the blast hole 30 as illustrated in Figure 4. The sheet 20 thereby forms a barrier preventing surrounding loose rock fragments from falling or collapsing into the blast hole 30 at or near the open end of the blast hole 30.

[0057] In another aspect, the invention provides a bench blasting method. The method includes drilling blast holes through a layer of preconditioned loose rock fragments 40 and into the stable rock below. The preconditioned layer 40 may be up to or more than 4 metres in depth. The method includes forming a substantially flat flexible sheet 20, such as the sheet 20 of Figure 2 or of Figure 6, into a curved form defining a longitudinal passage extending between openings at longitudinally opposite ends. The method further includes inserting one end of the curved sheet 20 into an open end of the blast hole 30 whereby the curved sheet 20 closely faces an internal surface 32 of the blast hole 30 within the layer of preconditioned loose rock fragments 40 and forms a barrier preventing the internal surface 32 of the blast hole 30 within the preconditioned layer of loose rock fragments 40 from falling or collapsing into the blast hole 30.

[0058] The methods can include forcing the flexible sheet 20 into a conical form tapering in an axial direction from a larger diameter opening at one of the

ends to a smaller diameter opening at the other end, inserting the smaller diameter end through the open end of a blast hole 30, and releasing the sheet 20 to assume a substantially cylindrical form within the blast hole 30. Alternatively, the method can involve forcing the flexible sheet 20 into a substantially cylindrical form and inserting one end through the open end of the blast hole 30 down to a desired depth. An elongated rod 50 can then be inserted through apertures 12, 14, 13, 15 within the sheet 20. The elongated rod 50 engages the surface surrounding the blast hole 30, as illustrated in Figure 3, to maintain the sheet 20 at the opening into the blast hole.

[0059] Preferably, the sheet 20 has a longitudinal length dimension that is 1 metre, 1.5 metres, 2 metres, 2.5 metres, 3 metres, 3.5 metres, 4 metres or more or any length therebetween. The length of the sheet 20 is selected based on geological requirements. Preferably, the methods include inserting the curved sheet 20 into the open end of the blast hole 30 whereby the curved sheet 20 closely faces an internal surface 32 of the blast hole 30 down to a depth of about 1 metre, about 1.5 metres, about 2 metres, about 2.5 metres, about 3 metres, about 3.5 metres, about 4 metres or more or any depth therebetween within the layer of preconditioned loose rock fragments 40.

[0060] The sheet 20 may remain in position within the blast hole 30 during a subsequent step of depositing explosives and other consumables into the blast hole 30. In embodiments of the methods, the sheet 20 may remain in the cylindrical form or may be manipulated into a conical form, such as by bending the sheet 20 into the conical form, as illustrated in Figure 3, such that the sheet 20 may operate as a funnel through which explosives and other consumables may be deposited into the blast hole 30.

[0061] In embodiments of the methods, the user selects a desired height for the sheet 20 that is located within the blast hole 30 by locating the elongated rod member 50 through a desired pair of apertures 12, 14, 13, 15. After the sheet 20 is inserted into the blast hole 30 the elongated rod member 50 rests on the surface 55 surrounding the blast hole 30. The apertures 12, 14, 13, 15 are positioned such that upon insertion of the elongated rod 50 therethrough,

the elongated rod 50 is offset from the central axis of the longitudinal passage extending through the curved sheet 20 to facilitate insertion into the blast hole 30 of lining material, loading with explosive, priming and providing any other consumables into the blast hole 30. The sheet 20 can then be partially withdrawn and formed into a funnel shape prior to depositing of stemming material into the blast hole 30. The sheet 20 may be removed from the blast hole 30 to assume a flat form for storage.

[0062] Figure 9 illustrates a deployment device 300 for deploying the sheet 20 into the blast hole 30. The device 300 includes a forming apparatus 310 adapted to form the flat flexible sheet 20 into a curved form for insertion into the open end of the blast hole 30 whereby the curved sheet closely faces the internal surface of the blast hole 30 and forms a barrier preventing surrounding loose rock fragments from falling or collapsing into the blast hole 30.

[0063] The deployment device 300 includes a plurality of the sheets 20 of Figure 6 arranged in a stack 315. The device 300 includes a sheet picker 320 and feeder 325 that is operable to pick an individual sheet 20 from the stack 315 and feed the sheet 20 to a vertical forming apparatus 330. In the embodiment illustrated in Figure 9, the picker 320 and the feeder 325 are comprised of an arrangement of driven belts operable to pick one of the sheets 20 at a time from the stack 315. However, any mechanical arrangement that is adapted to pick one sheet 20 from the stack 315 and feed the sheet 20 to the vertical forming apparatus 330 may constitute another embodiment of the invention. The forming apparatus 330 is operable to form the sheet 20 into a curved form defining a longitudinal passage extending between openings at longitudinally opposite ends. The forming apparatus 330 includes a vertically oriented shaped passage 332 with a wide opening at the top 334 and side walls tapering towards a narrower bottom outlet 336. However, any mechanical arrangement that is adapted to form the sheet 20 into a curved form defining a longitudinal passage extending between openings at longitudinally opposite ends may constitute another embodiment of the invention.

[0064] The outlet 336 of the forming apparatus 330 is adapted to be manually or automatically located over or to some extent into the open end of a blast hole 30. The sheet picker 320 and feeder 325 are operable to drive the individually picked sheet 20 through the passage 332 and through the outlet to thereby feed the curved sheet 20 into the open end of a blast hole 30. The forming apparatus 330 is operable to continue feeding the sheet 20 to a desired depth within the blast hole 30 and releases the sheet 20 when it has reached a predetermined depth. The released sheet 20, which has a substantially cylindrical form coaxial with the blast hole 30 as in Figure 4, thereby forms a barrier preventing surrounding loose rock fragments from falling or collapsing into the blast hole 30.

[0065] The deployment device 300 may be mounted to a vehicle (not shown) or a trailer (not shown) coupled to a vehicle or any other mobile apparatus adapted to be manoeuvred around a site comprising a plurality of blasting holes 30 that have previously been drilled. The vehicle or other mobile apparatus may be a truck that is operable manually by a driver or in an embodiment is configured to operate autonomously or semi-autonomously. The vehicle or other mobile apparatus may comprise a control module that includes a GPS location device and is adapted for controlling a drive means and steering means of the vehicle. The control module is adapted to receive or be programmed with the coordinates of the location of one or more of a plurality of blast holes and to autonomously manoeuvre the deployment device 300 to a location adjacent a first one of the blast holes.

[0066] When located adjacent the first blast hole 30, the control module may autonomously operate the deployment device 300 to deploy one of the sheets 20 into the blast hole 30. The control module may cause the outlet of the deployment device 300 to locate over the blast hole using the coordinates of the blast hole or using imagery from a camera mounted to the device 300 or the vehicle 350 or a combination of both. The control module may autonomously or semi-autonomously activate the sheet picker 320 and feeder 325 to drive the sheet 20 through the forming apparatus 330 and through the

outlet 336 to thereby feed the curved sheet 20 into the open end of a blast hole 30.

[0067] The control module may cause the deployment device 300, vehicle, trailer or other mobile apparatus to autonomously manoeuvre to a location adjacent the next blast hole for subsequent autonomous or semi-autonomous sheet 20 deployment. The control module may cause the platform to autonomously or semi-autonomously carry out sheet deployment across an array of blast holes.

[0068] Although the disclosure has been described with reference to specific examples, it will be appreciated by those skilled in the art that the disclosure may be embodied in many other forms, in keeping with the broad principles and the spirit of the disclosure described herein.

Claims:

1. An apparatus for preventing surrounding loose rock fragments from falling or collapsing into a blast hole, the apparatus including:

a resiliently flexible sheet including a pair of spaced apart longitudinally extending side edges and a pair of spaced apart laterally extending end edges, the sheet having a curved form defining a longitudinal passage extending between openings at longitudinally opposite ends, one end of the curved sheet being insertable into the open end of a blast hole, wherein in the curved form the side edges of the sheet are free and the sheet biases towards a flat form whereby and external surface of the curved sheet is biased against closely faces an internal surface of the blast hole and forms a barrier preventing surrounding loose rock fragments from falling or collapsing into the open end of the blast hole.

2. The apparatus of claim 1, wherein the sheet is adapted to be forced into a cylindrical or a conical form, wherein upon insertion through the open end of a blast hole the sheet assumes a substantially cylindrical form coaxially within the blast hole.

~~3. The apparatus of claim 1 or claim 2, wherein the sheet is formed of a sheet of resiliently flexible material biased towards a substantially flat form whereby in use within the blast hole the sheet biases against the internal surface of the blast hole.~~

~~4.3.~~ The apparatus of any one of claims 1 or claim 2 to 3, wherein the width of the sheet between the longitudinally extending side edges is less than the circumference of the blast hole, equal to the circumference of the blast hole or greater than the circumference of the blast hole.

~~5.4.~~ The apparatus of any one of claims 1 to ~~4~~3, wherein the longitudinally extending side edges taper at an end thereof to promote a more uniform cylindrical form of the sheet.

~~6.5.~~ The apparatus of any one of claims 1 to ~~5~~4, wherein the sheet is comprised of a normally flat sheet of flexible material.

~~7.6.~~ The apparatus of any one of claims 1 to ~~65~~, wherein the sheet includes apertures that are adapted to receive therethrough an elongated member for engaging a surface surrounding the blast hole to prevent further insertion of the sheet through the opening of the blast hole.

~~8.7.~~ The apparatus of any one of claims 1 to ~~76~~, wherein the sheet includes at least one opening through the sheet adjacent to each longitudinally extending side edge operable as a hand hold for a user to manually roll the sheet into the curved form.

~~9.8.~~ The apparatus of any one of claims 1 to ~~87~~, wherein the sheet includes at least one opening through the sheet adjacent to one of the end edges operable as a hand hold for a user to manually insert and remove the sheet relative to the open end of a blast hole.

~~10.9.~~ A method for preventing surrounding loose rock fragments from falling into a blast hole, the method including:

providing a resiliently flexible sheet including a pair of spaced apart longitudinally extending side edges and a pair of spaced apart laterally extending end edges, forming the sheet into a curved form defining a longitudinal passage extending between openings at longitudinally opposite ends,

inserting one end of the curved sheet into the open end of a blast hole wherein in the curved form the side edges of the sheet are free and the sheet biases towards a flat form whereby an external surface of the curved sheet biases against closely faces an internal surface of the blast hole substantially coaxially therewith forming a barrier preventing surrounding loose rock fragments from falling or collapsing into the blast hole.

~~11.10.~~ The method of claim ~~9~~~~10~~, further including:

forcing the flexible sheet into a cylindrical or a conical form,

inserting one end through the open end of a blast hole, and

releasing the sheet to assume a substantially cylindrical form coaxial with the blast hole to form a barrier preventing surrounding loose rock fragments from falling into the open end of the blast hole.

11. The method of claim 9 or claim 10, including inserting an elongated member through apertures in the sheet whereby the elongated member engages a surface surrounding the blast hole to prevent further insertion of the sheet through the open end of the blast hole

12. A bench blasting method including:

drilling blast holes through a layer of preconditioned loose rock fragments and into the stable rock below;

forming a substantially flat resiliently flexible sheet into a curved form defining a longitudinal passage extending between openings at longitudinally opposite ends;

inserting one end of the curved sheet into an open end of the blast hole wherein in the curved form the side edges of the sheet are free and the resilient sheet biases towards a flat form whereby an external surface of the curved sheet biases against~~closely faces~~ an internal surface of the blast hole within the layer of preconditioned loose rock fragments forming a barrier preventing the internal surface of the blast hole within the preconditioned layer from falling or collapsing into the blast hole.

13. The method of claim 12 including: forcing the flexible sheet into a cylindrical or conical form; inserting the sheet through the open end of a blast hole; and releasing the sheet to assume a substantially cylindrical form within the blast hole.

14. The method of claim 12 or claim 13, wherein the sheet has a longitudinal length dimension that is 1 metre, 1.5 metres, 2 metres, 2.5 metres or any length therebetween.

15. The method of any one of claims 12 to 14, wherein the curved sheet is inserted into the open end of the blast hole whereby the curved sheet closely faces an internal surface of the blast hole down to a depth of about 1 metre,

about 1.5 metres, about 2 metres, about 2.5 metres or any depth therebetween within the layer of preconditioned loose rock fragments.

16. A deployment device for deploying into a blast hole an apparatus for preventing surrounding loose rock fragments from falling or collapsing into the blast hole, the device including a forming apparatus adapted to form a flat flexible sheet into a curved form for insertion into the open end of a blast hole whereby the curved sheet closely faces an internal surface of the blast hole forming a barrier preventing surrounding loose rock fragments from falling or collapsing into the blast hole.

17. The device of claim 16, wherein the forming apparatus includes a shaped passage adapted to form the sheet into the curved form as the sheet moves through the passage.

18. The device of claim 17, wherein the shaped passage includes a wide opening at the top and side walls tapering towards a narrower bottom outlet.

19. The device of any one of claims 16 to 18, wherein the deployment device includes a store of a plurality of the sheets arranged in a stack.

20. The device of claim 19, including a sheet picker and feeder is operable to pick an individual sheet from the stack and feed the sheet through the shaped passage.

TRATADO EN COOPERACIÓN DE PATENTES

PCT

REPORTE PRELIMINAR INTERNACIONAL SOBRE PATENTABILIDAD

(Capítulo II del Tratado en Cooperación de Patentes)

(Artículo 36 y Regla 70 del PCT)

Referencia de archivo del solicitante o agente 3674	PARA ACCION ADICIONAL Ver Formulario PCT/IPEA/416	
Solicitud Internacional No. PCT/AU2018/050752	Fecha de presentación internacional (día/mes/año) 18 de julio de 2018	Fecha de prioridad (día/mes/año) 19 de julio de 2017
Clasificación Internacional de Patente (CIP) o clasificación nacional y CIP F42D 1/08 (2006.01)		
Solicitante TBS MINING SOLUTIONS PTY LTD		

1.

Este reporte es el reporte de examen preliminar internacional, establecido por esta Autoridad de Examen Preliminar Internacional bajo el Artículo 35 y transmitido al solicitante de acuerdo con el Artículo 36
2.

Este REPORTE consiste de un total de **5** hojas, incluyendo esta hoja de cubierta.
3.

Este reporte también está acompañado por ANEXOS, que comprenden:

a.

☒ (enviado al solicitante y a la Oficina Internacional) un total de **51** hojas, como se define a continuación:

☒ hojas de la descripción, reivindicaciones y/o figuras las cuales han sido modificadas y/o hojas que contienen rectificaciones autorizadas por esta Autoridad, a menos que esas hojas fueran reemplazadas o canceladas, y cualquier carta acompañante (ver Reglas 46.5, 66.8, 70.16, 91.2, y Sección 607 de las Instrucciones Administrativas).

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☐ hojas reemplazadas y cualquier carta acompañante, donde esta Autoridad considera que las hojas que reemplazan contienen una enmienda que va más allá de la divulgación en la solicitud internacional como fue presentada, o las hojas de reemplazo no estaban acompañadas por una carta que indica la base para las modificaciones en la solicitud como fue presentada, como se indica en el ítem 4 del Recuadro No. I y el Recuadro Complementario (ver Regla 70.16(b)).

b.

☐ (enviado a la Oficina Internacional únicamente) un total de (indicar el tipo y número de portadores electrónicos), que contiene un listado de secuencia, en la forma de un archivo de texto Anexo C/ST.25, como se indica en el
- 1

Cuadro Complementario Relacionado con el Listado de Secuencias (ver párrafo 3 ^{ter} del Anexo C de las Instrucciones Administrativas)	
4. Este reporte contiene indicaciones relacionadas con los siguientes ítems: ☒ Recuadro No. I Base del reporte ☐ Recuadro No. II Prioridad ☐ Recuadro No. III No establecimiento de opinión con relación a la novedad, nivel inventivo y aplicación industrial ☐ Recuadro No. IV Falta de unidad de invención ☒ Recuadro No. V Declaración razonada bajo el Artículo 35(2) con relación a la novedad, nivel inventivo o aplicación industrial; citaciones y explicaciones que soportan dicha declaración ☐ Recuadro No. VI Ciertos documentos citados ☐ Recuadro No. VII Ciertos defectos en la solicitud internacional ☒ Recuadro No. VIII Ciertas observaciones en la solicitud internacional	
Fecha de presentación de la demanda 17 de enero de 2019	Fecha de finalización de este reporte 8 de julio de 2019
Nombre y dirección de correo de la IPEA/AU OFICINA AUSTRALIANA DE PATENTES PO BOX 200, WODEN ACT 2606, AUSTRALIA Dirección electrónica: pct@ipaaustralia.gov.au	Oficial autorizado Jude Fernando OFICINA AUSTRALIANA DE PATENTES (ISO 9001 Servicio de Calidad Certificado) Teléfono No. +61262832419

Recuadro No. I Base del reporte

- Con relación al **idioma**, este reporte se basa en
 - ☒ la solicitud internacional en el idioma en el cual fue presentada
 - ☐ una traducción de la solicitud internacional en , el cual es el idioma de una traducción presentada para los propósitos de:
 - ☐ búsqueda internacional (bajo Reglas 12.3(a) y 23.1(b))
 - ☐ publicación de la solicitud internacional (bajo Regla 12.4(a))
 - ☐ examen preliminar internacional (bajo Reglas 55.2(a) y/o 55.3(a) y (b))
- Con relación a los **elementos*** de la solicitud internacional, este reporte se basa en *(las hojas de reemplazo que han sido presentadas a la Oficina receptora en respuesta a una invitación bajo el Artículo 14 son referidas en este reporte como “originalmente presentadas” y no se anexan a este reporte)*:
 - ☐ la solicitud internacional como fue presentada originalmente, o
 - ☒ la descripción: páginas , como fueron presentadas originalmente
 páginas **1-19** recibidas por esta Autoridad el **17 de enero de 2019** con la carta del **17 de enero de 2019**
 - ☒ las reivindicaciones: Nos. , como fueron presentadas originalmente
 Nos* , modificadas (junto con cualquier declaración) bajo Artículo 19
 Nos* **1-20**, recibidas por esta Autoridad el **17 de enero de 2019** con la carta del **17 de enero de 2019**
 - ☒ las figuras: páginas **1/5 – 5/5** como fueron presentadas originalmente
 Páginas , recibidas por esta Autoridad el con carta de
 - ☐ un listado de secuencias – Ver Recuadro Complementario Relacionado con Listado de Secuencias.
- ☐ Las modificaciones han resultado en la cancelación de:
 - ☐ la descripción, páginas _____
 - ☐ las reivindicaciones, Nos. _____
 - ☐ las figuras, hojas/figs. _____

-
- ☐ el listado de secuencias (*especificar*): _____
4. ☐ Este reporte ha sido establecido como si (algunas de) las modificaciones anexadas a este reporte y enunciadas más adelante no se hubieran hecho, ya que se consideran que van más allá de la divulgación presentada, o no estaban acompañadas por una carta que indica la base para las modificaciones en la solicitud como se presentó, como se indica en el Recuadro Complementario (Reglas 70.2(c) y (c-bis)):
- ☐ la descripción, páginas _____
- ☐ las reivindicaciones, Nos. _____
- ☐ las figuras, hojas /figs. _____
- ☐ el listado de secuencias (*especificar*): _____
5. ☐ Este reporte ha sido establecido:
- ☐ tomando en cuenta la **rectificación de un error obvio** autorizado por o notificado a esta Autoridad bajo la Regla 91 (Reglas 66.1 (d-bis) y 70.2(e)).
- ☐ sin tomar en cuenta la **rectificación de un error obvio** autorizado por o notificado a esta Autoridad bajo la Regla 91 (Reglas 66.4bis y 70.2(e)).
6. Con relación a búsquedas complementarias (Reglas 66.1ter y 70.2(f)):
- ☒ Una búsqueda complementaria fue llevada a cabo por esta Autoridad el 4 de julio de 2019
- ☐ Se han descubierto documentos adicionales relevantes durante la búsqueda complementaria
- ☐ No se llevó a cabo ninguna búsqueda complementaria por esta Autoridad porque ésta no serviría ningún propósito útil.
-

7. ☐ Se han recibido y tomado en cuenta reportes de búsqueda internacional complementarios de Autoridades _____ al establecer este reporte (Regla 45bis.8(b) y (c)).

* Si el ítem 4 aplica, algunas o todas de esas hojas se pueden marcar “reemplazadas”

Recuadro No. V Declaración razonada bajo el Artículo 35(2) con relación a la novedad, nivel inventivo o aplicación industrial; citaciones y explicaciones que soportan dicha declaración

1. Declaración			
Novedad (N)	Reivindicaciones	1-20	SI
	Reivindicaciones	NINGUNA	NO
Nivel inventivo (NI)	Reivindicaciones	1-20	SI
	Reivindicaciones	NINGUNA	NO
Aplicación industrial (AI)	Reivindicaciones	1-20	SI
	Reivindicaciones	NINGUNA	NO

2. CITACIONES Y EXPLICACIONES:

CITACIONES

D1: AU 199964504 A1 (SANLEO HOLDINGS PTY LTD) 24 de agosto de 2000
 D2: US 4055122 A (MULDROW, JR.) 25 de octubre de 1977

NOVEDAD (N)

Ninguno de los anteriores documentos D1 y D2, divulga, entre otras características de la reivindicación 1, *una hoja flexible que incluye un par de bordes laterales espaciados que se extienden longitudinalmente y un par de bordes de extremo espaciados que se extienden lateralmente, la hoja tiene una*

forma curvada que define un paso longitudinal que se extiende entre aberturas en extremos longitudinalmente opuestos, un extremo de la hoja curvada se inserta en el extremo abierto de un barreno en donde en la forma curvada los bordes laterales de la hoja son libres y la hoja se inclina hacia una forma plana por lo cual la superficie externa de la hoja curva se inclina contra una superficie interna del barreno para formar una barrera para prevenir que los fragmentos de roca circundantes sueltos se caigan o colapsen en el extremo abierto del barreno, como se define en la Reivindicación 1.

Observaciones similares aplican a las reivindicaciones 9, 12 y 16 por las mismas razones. Por lo tanto, la materia objeto de las reivindicaciones 1, 9, 12 y 16 es nueva y cumple con los requerimientos del Artículo 33(2) del PCT con relación a la novedad.

Las reivindicaciones 2-8, 10-11, 13-15 y 17-20 dependen de las reivindicaciones 1, 9, 12 y 16, respectivamente, y definen características adicionales a las definidas en las reivindicaciones independientes. Por lo tanto, la materia objeto de estas reivindicaciones también es novedosa y cumple con los requerimientos del Artículo 33(2) del PCT con relación a la novedad.

NIVEL INVENTIVO (NI)

Ninguno de los documentos del arte previo sugiere obviamente de forma individual o en combinación a un experto en la materia, *una hoja flexible que incluye un par de bordes laterales espaciados que se extienden longitudinalmente y un par de bordes de extremo espaciados que se extienden lateralmente, la hoja tiene una forma curvada que define un paso longitudinal que se extiende entre aberturas en extremos longitudinalmente opuestos, un extremo de la hoja curvada se inserta en el extremo abierto de un barreno en donde en la forma curvada los*

bordes laterales de la hoja son libres y la hoja se inclina hacia una forma plana por lo cual la superficie externa de la hoja curva se inclina contra una superficie interna del barreno para formar una barrera para prevenir que los fragmentos de roca circundantes sueltos se caigan o colapsen en el extremo abierto del barreno, como se define en la Reivindicación 1.

Observaciones similares aplican a las reivindicaciones 9, 12 y 16 por las mismas razones. Por lo tanto, la materia objeto de las reivindicaciones 1, 9, 12 y 16 no es obvia y cumple con los requerimientos del Artículo 33(3) del PCT con relación al nivel inventivo.

Las reivindicaciones 2-8, 10-11, 13-15 y 17-20 dependen de las reivindicaciones 1, 9, 12 y 16 y adicionan aspectos adicionales del concepto inventivo. Por lo tanto, la materia objeto de estas reivindicaciones también es no obvia y cumple con los requerimientos del Artículo 33(3) del PCT con relación al nivel inventivo.

APLICACIÓN INDUSTRIAL (AI)

La invención definida en las reivindicaciones es considerada que cumple con los requerimientos de Aplicación Industrial bajo el Artículo 33(4) del PCT porque puede ser hecha por, o usada en, la industria.

Recuadro No. VIII Ciertas observaciones sobre la solicitud internacional

Se hacen las siguientes observaciones sobre la claridad de las reivindicaciones, descripción, y las figuras o sobre la pregunta de si las reivindicaciones están completamente soportadas por la descripción:

Reivindicación 1

La reivindicación 1 define '*...por lo cual y superficie externa de la hoja curva se inclina contra...*'. Parece que esto se debe leer correctamente como '*...por lo cual una a superficie externa de la hoja curva se inclina contra...*'

Por ePCT

La Oficina Internacional de la OMPI

34, chemin des Colombettes

1211 Ginebra

SUIZA

Demanda de Capítulo II y Modificaciones de Artículo 34

Solicitud No : PCT/AU2018/050752

Solicitantes : TBS Mining Solutions Pty Ltd

**Título : UN MÉTODO Y APARATO PARA PREVENIR QUE
FRAGMENTOS DE ROCA INGRESEN O COLAPSEN EN UN
BARRENO**

Nuestra Ref. : 3674

Por el presente presentamos una Demanda para Examen Preliminar Internacional bajo el Capítulo II con respecto a la anterior Solicitud de Patente Internacional.

También se adjuntan modificaciones a la descripción y reivindicaciones presentadas bajo el Artículo 34 del PCT para consideración. En este sentido, adjuntamos una Declaración de Modificaciones Propuestas y una copia marcada y una limpia de las modificaciones.

Modificaciones

Para clarificar más el alcance de la invención, las reivindicaciones han sido revisadas. En particular, la reivindicación independiente 1 ha sido revisada para definir:

Un aparato para prevenir que fragmentos sueltos de roca circundantes se caigan o colapsen en un barreno, el aparato incluye:

una hoja flexible que incluye un par de bordes laterales espaciados que se extienden longitudinalmente y un par de bordes de extremo espaciados que se extienden lateralmente, la hoja tiene una forma curvada que define un paso longitudinal que se extiende entre aberturas en extremos longitudinalmente opuestos, un extremo de la hoja curvada se inserta en el extremo abierto de un barreno, en donde en la forma curvada los bordes laterales de la hoja son libres y la hoja se inclina hacia una forma plana por lo cual la superficie externa de la hoja curva se inclina contra una superficie interna del barreno para formar una barrera para prevenir que los fragmentos de roca circundantes sueltos se caigan o colapsen en el extremo abierto del barreno.

Como se modifica, la reivindicación 1 define “en la forma curvada los bordes laterales de la hoja son libres” (es decir, desconectados entre sí). Soporte para esta modificación se puede encontrar a lo largo de la descripción en los párrafos [0010], [0011] y en las figuras, en particular las Figuras 3, 4, 5, 8 y 9.

La reivindicación 1 es además revisada para clarificar que en la forma curvada la hoja define un paso longitudinal con aberturas “definidas por los bordes de extremo” en extremos longitudinalmente opuestos del paso. Soporte para esta modificación puede encontrarse a lo largo de la descripción incluyendo en el párrafo [0047] y en las Figuras 3, 4, 5, 8 y 9.

Como se modifica, la reivindicación 1 además define “en la forma curvada... la hoja flexible se inclina hacia una forma plana”. Soporte para esta modificación se encuentra en la reivindicación 3 y el párrafo [009] de la descripción.

Como se modifica, la reivindicación 1 además define “por lo cual una superficie externa de la hoja curva se inclina contra una superficie interna del barreno”.

Soporte para esta modificación se encuentra a lo largo de la descripción incluyendo en los párrafos [0020] y [0049].

La reivindicación independiente 9, anteriormente reivindicación 10, y la reivindicación independiente 12 han sido modificadas de forma similar. la reivindicación 3 ha sido eliminada y se ha incluido la nueva reivindicación 11. Soporte para la nueva reivindicación 11 se encuentra en la descripción incluyendo en los párrafos [0037] y [0052] y la Figura 4.

NOvedad y Nivel Inventivo

En el ISR y la WO, hay 2 referencias citadas, específicamente:

D1: AU 199964504 A1 (SANLEO HOLDINGS PTY LTD) 24 de agosto de 2000

D2: US 4055122 A (MULDROW, JR.) 25 de octubre de 1977

En la WO, en la página 3, el Examinador indica que:

Las reivindicaciones 5, 7-9 y 16-20 son novedosas;

Las reivindicaciones 17-20 son novedosas e inventivas; y

Las reivindicaciones 1 a 4, 6 y 10 a 15 no son novedosas o inventivas.

D1: AU 199964504 A1 (SANLEO HOLDINGS PTY LTD)

Esta es la única referencia citada en el ISR y WO con relación a la novedad y nivel inventivo de la invención reivindicada. Esta referencia se relaciona con revestimiento de barrenos, en particular, insertar un revestimiento líquido impermeable en un barreno y llenar el revestimiento con explosivo. Entre otras cosas, el revestimiento permite que se usen explosivos no resistentes al agua (página 15, líneas 3 a 5).

El Examinador se refiere a las Figuras 2 y 4B y la página 10, línea 6 de la descripción, como que divulga un aparato que incluye todas las características de

la invención actualmente reivindicada. Más ampliamente, esta parte de la referencia citada divulga “una combinación del revestimiento del agujero de la invención y significa que soporta el extremo abierto para mantener abierto el extremo abierto para facilitar la inserción de explosivo en el revestimiento y para soportar el extremo abierto próximo a la boca del agujero” (página 9, línea 35 a página 10, línea 2). “Los medios de soporte pueden ser de cualquier forma, sin embargo, es preferible que los medios de soporte sean un medio de soporte con forma de cono (generalmente una forma de cono hueco). El medio de soporte es de un tamaño tal que se sumerge en la manga en la parte superior del agujero. Típicamente, el medio de soporte está hecho de cartón; cartón corrugado; plástico, por ejemplo, una materia con el extremo cerrado removido; madera; metal o cerámica. Típicamente, el medio de soporte está hecho de cartón o plástico... En otra forma, el medio de soporte es un cono o anillo u otra forma adecuada con un medio para soportar el cono o anillo (el cual puede ser circular, rectangular, cuadrado, elíptico u otra forma adecuada) los cuales pueden ser piernas (por ejemplo, dos, tres, cuatro o cinco piernas). En otra forma, el medio de soporte es un dispositivo extendido anularmente” (página 10, líneas 3 a 23).

En consecuencia, D1 ampliamente divulga un medio de soporte hecho de cartón o plástico formado en una forma cónica fija (aunque se menciona una alternativa de forma de “anillo”, pero no se ilustra) para mantener abierto el revestimiento en la parte superior del barreno para permitir que el explosivo sea depositado en el revestimiento. Dos modalidades del medio de soporte se divulgan en las figuras incluyendo:

- un embudo con forma cónica que se ubica en la parte superior del revestimiento y se acuña contra el labio del barreno y dobla el revestimiento sobre la parte superior del embudo (ver Figuras 2, 4B, 4C, 4D adelante); y

- un embudo con forma cónica invertida ubicado en el suelo alrededor del barrenado y que retira la parte superior del revestimiento a través de la mitad del embudo y que agarra el revestimiento al extremo superior abierto del embudo invertido (ver la Figura 9 más adelante).

Como se divulga en D1, el medio de soporte puede formarse de una hoja plana de material doblado en una forma cónica y sus bordes laterales libres asegurados, o de otra forma se puede formar de un miembro unitario con forma cónica sin ninguna unión o junta. Se menciona una modalidad con forma alterna de anillo, sin embargo, no se suministran más detalles con respecto a su estructura.

La divulgación de D1 sugiere que un miembro de soporte con forma de cono o anillo puede incluir un medio para soportar el cono o anillo (el cual puede ser circular, rectangular, cuadrado, elíptico u otra forma adecuada) las cuales pueden ser piernas (por ejemplo, dos, tres, cuatro o cinco piernas). Sin embargo, no hay mayor divulgación de una configuración o uso de dichas modalidades.

Con relación a la modalidad ilustrada en la Figura 2, la cual es reproducida más adelante, la divulgación relevante está en la página 19, líneas 19-23, la cual suministra “un medio de soporte se ilustra como una pieza de cartón la cual ha sido doblada en un cono 9 y se fija en lugar por medio de dos piezas de cinta de sellado 10, 10a”.

El uso del medio de soporte se ilustra en las Figuras 4B, 4C y 4D, reproducidas a continuación, y se describe en la página 20, líneas 23 a 37 y página 21, líneas 1 a 21. La referencia divulga que “el usuario empuja el cono 9 hacia abajo en la manga 1 hasta que el cono 9 esté en contacto con la abertura de agujero 14. La Figura 4B muestra el cono 9 en contacto con la abertura de agujero 14 después que ha sido

ubicado en la manga plástica 1. En esta posición, el cono 9 se atora en la abertura de agujero 14 después que se ha ubicado en la manga plástica 1". Esta divulgación define un revestimiento a ser ubicado en un agujero y un embudo con forma de cono fijo a ser ubicado dentro del extremo abierto del revestimiento y que se acuña contra la abertura del agujero. El extremo del revestimiento luego se dobla sobre la parte superior y en la abertura dentro del embudo con forma de cono como se muestra en las Figuras 4C y 4D.

Otra modalidad se ilustra en la Figura 9 y se describe en la página 22, línea 29 a la página 23, línea 11. Esta modalidad define el embudo con forma de cono a ser ubicado en una posición invertida sobre el agujero de modo que el extremo de diámetro mayor descansa sobre el suelo alrededor del agujero y el revestimiento es retirado hacia arriba a través de la abertura de diámetro menor por encima del nivel de suelo y se fija al mismo.

En consecuencia, esta referencia no enseña ni sugiere *"una hoja flexible que incluye un par de bordes laterales espaciados que se extienden longitudinalmente... en donde en la forma curvada los bordes laterales de la hoja son libres y la hoja se inclina hacia una forma plana por lo cual la superficie externa de la hoja curva se inclina contra una superficie interna del barreno"* como se define en la invención actualmente reivindicada, como es modificada.

La referencia citada enseña una forma dispositivo cónico de forma fija, aunque uno se puede formar de una hoja plana con bordes libres fijos juntos, de modo que el dispositivo de embudo se puede acuñar, efectivamente en un ajuste de interferencia, en el extremo abierto del agujero. En contraste, la presente invención define un dispositivo con bordes laterales libres de modo que las propiedades flexibles del material que comprende la hoja hacen que éste se empuje contra una

forma plana de modo que la superficie externa de la hoja se apoya contra la superficie interna del barreno. La divulgación de D1 enseña un dispositivo de soporte con una geometría fija y, como tal, se aleja de la presente invención y sus bordes laterales libres y su geometría variable implícita.

Además, las reivindicaciones dependientes 2, 10 y 13, como se modifican, definen que la hoja asume, en uso, una forma sustancialmente cilíndrica coaxialmente dentro del barreno. En contraste, D1 enseña suministrar miembros de soporte con forma cónica en un barreno. Como tal, presentamos que la materia objeto definida en las reivindicaciones dependientes 2, 10 y 13, como se modifica, no es ensañada o sugerida por la referencia citada y como tal, definen materia objeto novedosa e inventiva.

D1 divulga en la página 9, línea 35 a página 10, línea 2, “De acuerdo con otra modalidad de esta invención, se suministra una combinación del revestimiento de agujero de la invención y medios para soportar el extremo abierto para mantener abierto el extremo abierto para facilitar la inserción de explosivos en el revestimiento y para soportar el extremo abierto cercano a la boca del agujero”. Así, el medio de soporte de D1 está destinado para uso como “soporte” del extremo abierto de un revestimiento en el extremo abierto del barreno para permitir que éste sea llenado con explosivos. No hay enseñanza o sugerencia del medio de soporte que se adapta para soportar la superficie interna del barreno o para prevenir que fragmentos sueltos de roca caigan o colapsen en un barreno. No hay ninguna mención o sugerencia en D1 del problema al cual se relaciona la presente invención y, por lo tanto, un experto en la materia no habría considerado la divulgación de D1 como relevante para abordar el problema que busca abordar la presente invención.

Conclusiones

La referencia citada D1 no divulga todas las características de la reivindicación 1, como es modificada. Como tal, la reivindicación 1 es novedosa sobre esta referencia.

Además, la divulgación de D1 no prevé el problema que busca superar la presente invención, específicamente, el problema de fragmentos sueltos de rocas circundantes cayéndose o colapsando dentro de una abertura de barreno, ni mencionar que enseñan o sugieren la invención actualmente reivindicada. Por lo tanto, D1 no priva la invención de la reivindicación 1, como es modificada, de un nivel inventivo.

Por las mismas razones, presentamos que las reivindicaciones independientes 9 y 12, como son modificadas, también son novedosas e involucran un nivel inventivo sobre D1. También, por las razones definidas anteriormente, la materia objeto definida en las reivindicaciones dependientes 2, 10 y 13, como son modificadas, tampoco es enseñada o sugerida por la divulgación de D1 de modo que la materia objeto definida en estas reivindicaciones también es novedosa e involucra un nivel inventivo sobre D1.

Se solicita consideración favorable.

Respetuosamente

Daniel A. McKinley

[Firmado]

Director

daniel@gestalt.law

MÉTODO Y APARATO PARA EVITAR QUE FRAGMENTOS DE ROCA INGRESEN O COLAPSEN DENTRO DE UN BARRENO

ÁREA TÉCNICA

[001] La presente invención se relaciona con el área de las voladuras, particularmente en las áreas de minería y cantería.

ANTECEDENTES DE LA INVENCION

[002] Los minerales tales como el mineral de hierro y carbón pueden ser recuperados con una variedad de métodos que incluyen métodos de minería por corte abierto sobre el suelo. Tales métodos pueden involucrar el uso de voladuras con explosivos a granel para soltar grandes cantidades de mineral para excavación y recuperación mediante subsiguiente manipulación mediante excavadoras y lo similar. El proceso de voladura da por resultado el desmenuzamiento de roca que contiene el mineral en partículas de variados tamaños. Es deseable que el proceso de voladura produzca material con un tamaño de partícula promedio que sea lo menor posible para minimizar la necesidad de desmenuzamiento adicional mediante triturado, molienda, vibración y otros procesos.

[003] La voladura en banco es un proceso que involucra el taladrado de orificios en la roca a profundidades, en diámetros y con separación y llenado de los orificios con material explosivo para formar una carga en columna que fractura la roca de una manera controlada. Los barrenos pueden tener diámetros de tamaño de 270 hasta 311 o incluso hasta 350 milímetros y mayores y tener profundidades de hasta 50 metros o más. Estos barrenos son llenados con materiales explosivos a granel que son, al menos en parte, explosivos de baja velocidad en base a nitrato de amonio. El material explosivo estará en contacto con un detonador y cubierto o “contenido” con material tal como agregados. El detonador es activado eléctricamente o no eléctricamente para hacer que el explosivo detone.

[004] La mayoría de la roca que es fracturada después de una operación de voladura es retirada del sitio mediante excavadoras para procesamiento adicional o remoción como desperdicio. Sin embargo, pueden quedar cantidades significativas de fragmentos de roca sueltos, o material “preacondicionado”, en el banco a partir de la región sub-taladrada después de alcanzar el Nivel Reducido (NR). Puede ser deseable emplear longitudes de sub-taladrado sustancialmente incrementadas para aumentar deliberada y significativamente la profundidad de la capa preacondicionada. Una profundidad de la capa preacondicionada de hasta 4 metros o más puede mejorar la eficiencia del proceso de desmenuzamiento mediante la maximización del volumen de fragmentación fina que resulta de la subsiguiente operación de voladura.

[005] En la ubicación en donde deben taladrarse barrenos para una subsiguiente operación de voladura, quedan estos fragmentos o material “preacondicionado”. Después que han sido taladrados los barrenos, pueden colapsar fragmentos de roca sueltos o material preacondicionado dentro de las aberturas de barrenos completados para llenar parcialmente o incluso bloquear el orificio taladrado antes de depositar el material explosivo. Cuando hasta los primeros cuatro o cinco metros de la profundidad del barreno están atravesando la capa preacondicionada, el riesgo de colapso de material dentro de los barrenos es agudo. Los ambientes húmedos también pueden lubricar los fragmentos de roca sueltos, exacerbando el colapso de fragmentos de roca sueltos dentro de los barrenos.

[006] Cualquier discusión del arte previo a lo largo de la presente no debe ser considerada de ningún modo como una admisión de que cualquiera de los documentos u otro material de referencia fue publicado, conocido o forma parte del conocimiento general común.

BREVE DESCRIPCIÓN DE LA INVENCION

[007] De manera concordante, en un aspecto, la invención provee un aparato para evitar que fragmentos circundantes de roca sueltos caigan o colapsen dentro de un barreno, incluyendo el aparato: una hoja resiliestamente

flexible que incluye un par de bordes laterales separados que se extienden longitudinalmente y un par de bordes de extremo separados que se extienden lateralmente, teniendo la hoja una forma curvada que define un pasaje longitudinal que se extiende entre aberturas en extremos longitudinalmente opuestos, siendo un extremo de la hoja curvada insertable dentro del extremo abierto de un barreno, lo cual en la forma curvada los bordes laterales de la hoja están libres y la hoja se inclina hacia una forma plana donde la superficie externa de la hoja curvada se inclina contra una superficie interna del barreno y forma una barrera que evita que los fragmentos circundantes de roca sueltos caigan o colapsen dentro del barreno.

[008] Preferiblemente, la hoja está adaptada para ser forzada en forma sustancialmente cilíndrica o cónica en donde con la inserción a través del extremo abierto de un barreno la hoja asume una forma sustancialmente cilíndrica coaxialmente dentro del barreno. Preferiblemente, la hoja está adaptada para ser manipulada manualmente en forma cilíndrica o cónica.

[009] De acuerdo con la invención, la hoja está formada en base a un material resiliestamente flexible con tendencia a una forma sustancialmente plana, por lo cual durante el uso dentro de un barreno la hoja tiende a estar contra la superficie interna del barreno. Ventajosamente, las propiedades resilientes del material del cual está hecho la lámina causa que la superficie externa de la lámina se incline contra la superficie interna del barreno formando así una barrera que evita que los fragmentos de roca suelta caigan o colapsen en el agujero de la explosión.

[0010] En formas de realización, los bordes laterales que se extienden longitudinalmente se ahúsan en un extremo de los mismos. Cuando la hoja es doblada sobre sí misma, manualmente o de otra manera, y los bordes paralelos opuestos transversalmente son llevados uno hacia el otro, el ahusamiento de los extremos de los bordes laterales promueve una forma cilíndrica más uniforme de la hoja.

[0011] En formas de realización, el ancho de la hoja entre los bordes laterales que se extienden longitudinalmente es menor que la circunferencia del barreno. Preferiblemente, la hoja está adaptada para asumir una forma sustancialmente cilíndrica dentro del barreno en donde los bordes laterales de la hoja están separados. Preferiblemente, la hoja está adaptada para ser forzada, tal como al ser manipulada manualmente, en una forma cilíndrica. Alternativamente, la hoja puede ser manipulada mecánicamente en una forma cilíndrica. En formas de realización, el ancho de la hoja entre los bordes laterales que se extienden longitudinalmente es igual a la circunferencia del barreno o es mayor que la circunferencia del barreno. Debe apreciarse que se prefiere un ancho menor que la circunferencia del barreno ya que esto se adapta a la distorsión y no uniformidad del barreno y también requiere menos aberturas en la hoja para uso como manijas (asas) minimizando de este modo cualquier debilitamiento de la hoja. Sin embargo, las formas de realización de la hoja en donde el ancho de la hoja es igual a, o mayor que la circunferencia del barreno también satisface los amplios objetivos de la invención los cuales son formar una barrera que evita que los fragmentos de roca circundantes sueltos caigan o colapsen dentro del barreno.

[0012] En formas de realización, los bordes laterales que se extienden longitudinalmente se ahúsan en un extremo de los mismos. Cuando la hoja es doblada sobre sí misma y los bordes paralelos opuestos transversalmente son llevados uno hacia el otro, el ahusamiento de los extremos de los bordes laterales promueve una forma cilíndrica más uniforme de la hoja.

[0013] Preferiblemente, los bordes laterales que se extienden longitudinalmente incluye cada uno pestañas alargadas adaptadas para hacer tope entre sí cuando la hoja está en forma curvada.

[0014] En formas de realización, la hoja flexible comprende una hoja sustancialmente plana de material flexible. La hoja flexible tiene una forma normalmente plana y está adaptada para ser enrollada en forma curvada. Esto es, en el estado de reposo, la hoja tenderá hacia una forma sustancialmente plana.

[0015] En formas de realización, la hoja incluye al menos una abertura a través de la hoja adyacente a cada borde lateral que se extiende longitudinalmente, operable como una manija para que un usuario enrolle manualmente la hoja en la forma curvada. En formas de realización, la hoja incluye al menos una abertura a través de la hoja adyacente a uno de los bordes de extremo, operable como una manija para que un usuario inserte y retire manualmente la hoja en relación con el extremo abierto de un barreno.

[0016] En formas de realización, la hoja incluye un par de aberturas a través de la hoja que están adaptadas para recibir a través de las mismas un miembro alargado para acoplarse a una superficie circundante al barreno para evitar la inserción adicional del panel a través de la abertura del barreno. Preferiblemente, el par de aberturas están situadas adyacentes a cada borde lateral que se extiende longitudinalmente y están alineadas entre sí a lo largo de la longitud de la hoja para recibir el miembro longitudinal a través de las mismas perpendicularmente a la longitud de la hoja.

[0017] En otro aspecto, la invención provee un método para evitar que fragmentos circundantes de roca sueltos caigan o colapsen dentro de un barreno, incluyendo el método: proveer una hoja resilientemente flexible que incluye un par de bordes laterales separados que se extienden longitudinalmente y un par de bordes de extremo separados que se extienden lateralmente, conformar la hoja en una forma curvada que define un pasaje longitudinal que se extiende entre aberturas en extremos opuestos longitudinalmente, insertar un extremo de la hoja curvada dentro del extremo abierto de un barreno mediante lo cual en la forma curvada los extremos laterales de la hoja están libres y la hoja se inclina hacia una forma plana mediante lo cual una superficie externa de la hoja curvada se inclina contra una superficie interna del barreno y forma sustancialmente de manera coaxial una barrera que evita que los fragmentos circundantes de roca sueltos caigan o colapsen dentro del barreno.

[0018] Preferiblemente, el método incluye situar la hoja dentro del barreno dentro de una capa de fragmentos de roca sueltos preacondicionados para

formar una barrera que evita que la superficie interna del barreno dentro de la capa preconditionada caiga o colapse dentro del barreno. Preferiblemente, el método puede incluir insertar un miembro alargado a través de aberturas en la hoja, mediante lo cual el miembro alargado se acopla a una superficie que rodea el barreno para evitar una mayor inserción de la hoja a través del extremo abierto del barreno.

[0019] En una forma de realización, el método incluye: forzar la hoja flexible en una forma cónica que se ahúsa en una dirección axial desde una abertura de diámetro mayor en uno de los extremos hasta una abertura de diámetro menor en el otro extremo, insertar el extremo de diámetro menor a través del extremo abierto de un barreno, y liberar la hoja para que asuma una forma sustancialmente cilíndrica dentro del barreno formando de este modo una barrera que evita que fragmentos circundantes de roca sueltos caigan o colapsen dentro del barreno.

[0020] En otra forma de realización, el método incluye: forzar la hoja flexible en una forma cilíndrica e insertar la hoja a través del extremo abierto de un barreno y liberar la hoja mediante lo cual la hoja tiende a estar contra la superficie interna del barreno formando una barrera que evita que fragmentos circundantes de roca sueltos caigan o colapsen dentro del barreno.

[0021] Preferiblemente, el método incluye forzar la hoja manualmente en forma cónica o cilíndrica. Alternativamente, el método puede incluir forzar mecánicamente la hoja en la forma cónica o cilíndrica.

[0022] Formas de realización del aparato y método son ventajosas en cuanto proveen la instalación conveniente de una barrera en el extremo abierto de un barreno que evita que fragmentos circundantes de roca sueltos caigan o colapsen dentro del barreno.

[0023] Formas de realización del aparato y método son ventajosas en cuanto operan para mantener un cuello abierto en el barreno para permitir facilidad en el depósito de explosivos y otros consumibles típicos dentro del barreno.

[0024] En otro aspecto, la invención provee un método de voladura en banco que incluye: perforar barrenos a través de una capa de fragmentos de roca sueltos preacondicionados y dentro de la roca estable por debajo; forzar una hoja reslientemente flexible sustancialmente plana en una forma curvada que define un pasaje longitudinal y aberturas en extremos longitudinalmente opuestos insertando un extremo de la hoja curvada a extremo abierto del barreno en lo cual in la forma curvada los extremos laterales de la hoja están libres y la hoja resilente se inclina hacia una forma plana en lo cual una superficie externa de la hoja curvada se inclina a una superficie interna del barreno dentro de la capa de fragmentos de roca sueltos preacondicionada y forma una barrera que evita que la superficie interna del barreno dentro de la capa preacondicionada caiga o colapse dentro del barreno.

[0025] Preferiblemente, el método incluye forzar la hoja flexible en una forma cónica que se ahúsa en una dirección axial desde una abertura de diámetro mayor en uno de los extremos hasta una abertura de diámetro menor en el otro extremo, insertar el extremo de diámetro menor a través del extremo abierto de un barreno y liberar la hoja para que asuma una forma sustancialmente cilíndrica dentro del barreno. En otra forma de realización, el método incluye forzar la hoja flexible en una forma cilíndrica e insertar la hoja a través del extremo abierto de un barreno y liberar la hoja mediante lo cual la hoja tiende a estar contra la superficie interna del barreno.

[0026] Preferiblemente, el método incluye forzar la hoja manualmente en la forma cónica o cilíndrica. Alternativamente, el método puede incluir forzar mecánicamente la hoja en la forma cónica o cilíndrica.

[0027] Preferiblemente, la hoja tiene una dimensión de largo longitudinal que es de 1 metro, 1,5 metros, 2 metros, 2,5 metros, 3 metros, 3,5 metros, 4 metros o más o cualquier longitud entre ellas según lo determinan los requerimientos geológicos. Preferiblemente, el método incluye insertar la hoja curvada dentro del extremo abierto del barreno mediante lo cual la hoja curvada enfrenta estrechamente una superficie interna del barreno hacia abajo hasta una profundidad de aproximadamente 1 metro, aproximadamente 1,5 metros,

aproximadamente 2 metros, aproximadamente 2,5 metros, aproximadamente 3 metros, aproximadamente 3,5 metros, aproximadamente 4 metros o más o cualquier profundidad entre ellas dentro de la capa de fragmentos de roca sueltos preacondicionados según lo determinan los requerimientos geológicos.

[0028] En un aspecto, la invención provee un dispositivo de despliegue para desplegar dentro de un barreno un aparato para evitar que fragmentos circundantes de roca sueltos caigan o colapsen dentro del barreno, incluyendo el dispositivo un aparato conformador adaptado para conformar una hoja flexible plana en una forma curvada para inserción dentro del extremo abierto de un barreno mediante lo cual la hoja curvada enfrenta estrechamente una superficie interna del barreno formando una barrera que evita que fragmentos circundantes de roca sueltos caigan o colapsen dentro del barreno.

[0029] Preferiblemente, el aparato conformador incluye un pasaje con forma adaptado para conformar la hoja en una forma curvada a medida que la hoja se mueve a través del pasaje.

[0030] En una forma de realización, el pasaje con forma incluye una amplia abertura en la parte superior y paredes laterales que se ahúsan hacia una salida inferior más estrecha.

[0031] Preferiblemente, el dispositivo de despliegue incluye un almacenamiento de una pluralidad de hojas dispuestas en forma de pila. El dispositivo de despliegue preferiblemente incluye un recolector y alimentador de hojas que es operable para recoger una hoja individual desde la pila y alimentar la hoja a través del pasaje con forma.

BREVE DESCRIPCIÓN DE LAS FIGURAS

[0032] La presente invención será ahora descrita en más detalle con referencia a formas de realización preferidas ilustradas en las figuras acompañantes, en donde:

[0033] La Figura 1 ilustra una sección frontal de un extremo abierto de un único barreno taladrado para una operación de voladura;

[0034] La Figura 2 ilustra una vista en perspectiva de un aparato para evitar que fragmentos circundantes de roca sueltos caigan dentro de un barreno, tal como el barreno de la Figura 1, en donde el aparato incluye una hoja sustancialmente rectilínea resilientemente flexible que tiene un par de bordes opuestos sustancialmente paralelos;

[0035] La Figura 3 ilustra una vista en perspectiva del aparato de la Figura 2, en donde la hoja resilientemente flexible es forzada en una forma cónica que se ahúsa en una dirección axial desde un extremo de diámetro mayor, hacia un extremo de diámetro menor, en donde el extremo de diámetro menor está insertado a través del extremo abierto del barreno de la Figura 1;

[0036] La Figura 4 ilustra una vista en perspectiva del aparato de la Figura 2, en donde después que el extremo de diámetro menor está insertado a través del extremo abierto de un barreno, la hoja es liberada para asumir una forma sustancialmente cilíndrica coaxial con el barreno formando de este modo una barrera que evita que fragmentos circundantes de roca sueltos caigan dentro del barreno y en donde un miembro alargado está insertado a través de aberturas horizontalmente alineadas en el aparato cilíndrico para acoplarse a una superficie circundante del barreno para evitar una inserción adicional de la hoja a través de la abertura del barreno;

[0037] La Figura 5 ilustra una vista superior del aparato de la Figura 2, en donde pestañas alargadas a lo largo de los bordes paralelos opuestos están cercanamente separados y están adaptados para hacer tope entre sí;

[0038] La Figura 6 ilustra una vista en perspectiva de un aparato de acuerdo con otra forma de realización de la invención;

[0039] La Figura 7 ilustra una vista en planta de una forma de realización de la invención que incluye un aparato para evitar que fragmentos circundantes

de roca sueltos caigan o colapsen dentro del barreno, en donde el aparato incluye una hoja resiliestamente flexible, sustancialmente rectilínea, que tiene un par de bordes opuestos sustancialmente paralelos en donde los bordes se ahúsan en un extremo;

[0040] La Figura 8 ilustra una vista en perspectiva del aparato de la Figura 7 en donde la hoja es forzada en una forma cilíndrica; y

[0041] La Figura 9 ilustra un aparato para desplegar la hoja de cualquiera de las formas de realización de las Figuras 1 a 8 dentro del barreno.

[0042] La invención será ahora descrita en mayor detalle con referencia a las formas de realización ilustradas en las Figuras.

DESCRIPCIÓN DETALLADA

[0043] Con referencia a las Figuras 1 a 5, se muestra una forma de realización de la invención que comprende un aparato 10 que, en uso, está adaptado para evitar que fragmentos 40 circundantes de roca sueltos caigan o colapsen dentro del barreno 30. En la Figura 1, se ilustra una sección frontal de un extremo abierto de un único barreno 30, aunque debe apreciarse que serían taladrados una multitud de tales barrenos 30 para una única operación de voladura. El barreno 30 puede ser taladrado con un diámetro tan grande como 270 a 311 milímetros o tanto como 350 milímetros o más y a profundidades de hasta 50 metros o más. Después del taladrado, el barreno 30 es llenado con material explosivo apropiado para las condiciones del suelo, tal como una mezcla de nitrato de amonio y *fuel oil* (ANFO, por sus siglas en inglés) o una emulsión de una mezcla de los mismos y está preparado para la detonación.

[0044] La mayor parte de la roca que es fragmentada después de una operación de voladura es retirada del sitio de una mina mediante excavadoras para procesamiento adicional o remoción como desperdicio. Sin embargo, pueden permanecer cantidades significativas de fragmentos de roca sueltos o fragmentos de roca “preacondicionados” en el banco de mina a partir de la

región sub-taladrada después de alcanzar el Nivel Reducido (NR). Puede ser deseable emplear longitudes de sub-taladrado sustancialmente incrementadas para aumentar deliberada y significativamente la profundidad de la capa preacondicionada. Una profundidad de la capa preacondicionada de hasta 4 metros o más puede mejorar la eficiencia del proceso de desmenuzamiento mediante la maximización del volumen de fragmentación fina que resulta de la subsiguiente operación de voladura. Estos fragmentos de roca preacondicionados permanecen en la ubicación donde se van a taladrar barrenos para una subsiguiente operación de voladura. Como se muestra en la Figura 1, el barreno 30 comprende un extremo abierto superior 33 que está rodeado por una capa de preacondicionamiento que comprende fragmentos 40 de roca sueltos. La capa de fragmentos 40 de roca preacondicionados puede tener una profundidad de hasta 4 o más metros. Como tal, hasta los primeros 4 o más metros de la profundidad del barreno 30 por debajo del extremo abierto superior 33 pueden estar atravesando la capa preacondicionada de fragmentos 40 de roca sueltos. Una cantidad de los fragmentos 40 de roca sueltos puede colapsar dentro del barreno 30 en o hacia el extremo abierto superior 33 del barreno 30.

[0045] La Figura 2 ilustra una forma de realización del aparato 10 de la presente invención. El aparato 10 incluye una hoja 20 flexible, que preferiblemente comprende un material resiliente, tal como un material polimérico resiliientemente flexible que puede estar reforzado con nylon o algún otro refuerzo flexible. El material a partir del cual está formada la hoja 20 flexible es un compuesto de polietileno de alta densidad (HDPE por sus siglas en inglés), que puede estar o no reforzado, con propiedades antiestáticas. La hoja 20 incluye un par de superficies opuestas 18, 19 y está preferiblemente conformada en forma rectangular de modo que incluye un primer par de bordes 21, 23 laterales paralelos, separados y que se extienden longitudinalmente y un segundo par de bordes 22, 24 de extremo paralelos, separados, que se extienden lateralmente. En la forma de realización de las Figuras 1 a 5 el primer par de bordes 21, 23 laterales paralelos comprenden pestañas alargadas 25, 27 que se extienden a lo largo sustancialmente de las longitudes completas de los mismos. Debe apreciarse que el segundo par de bordes 22, 24 de extremo,

separados y paralelos, no necesariamente deben ser paralelos. La hoja 20 incluye una serie de aberturas 12, 13, 14, 15 que están dispuestas con separación lateral y pares 12, 14 y 13, 15, lateralmente separados y longitudinalmente alineados. La hoja 20 incluye una abertura 16 adicional situada adyacente a uno de los bordes de extremo 16 que funciona como una manija.

[0046] Las Figuras 3 y 4 ilustran la hoja 20 en uso. Como se muestra en la Figura 3, la hoja 20 está adaptada para ser forzada desde su forma plana de reposo en una forma curvada, tal como una forma cilíndrica o cónica. La hoja 20 puede ser forzada en una forma cilíndrica o cónica doblando manual o mecánicamente la hoja 20. Cuando la hoja 20 está en forma cilíndrica o, como se ilustra en la Figura 3, en forma cónica, la hoja 20 define un pasaje longitudinal que se ahúsa en dirección axial desde un extremo de diámetro mayor 11 que define una abertura de diámetro mayor hasta un extremo de diámetro menor 12 que define una abertura de diámetro menor. El extremo de diámetro mayor 11 comprende uno de los bordes 22 de extremo más cercano a la serie de aberturas 12, 13, 14, 15. El extremo de diámetro menor 12 comprende el otro de los bordes 24 de extremo más lejano de la serie de aberturas 12, 13, 14, 15. El extremo de diámetro menor 12 tiene un diámetro global que es más pequeño que el diámetro del extremo abierto 33 del barreno 30. El extremo de diámetro menor 12 de la hoja 20, cuando está en la forma cónica, está insertado dentro del extremo abierto 33 del barreno 30.

[0047] Después que el extremo de diámetro menor 12 de la hoja 20 está insertado dentro del extremo abierto 33 del barreno 30, la hoja 20 es luego liberada de modo que las propiedades resilientes del material a partir del cual está formada la hoja 20 permite que la hoja 20 se expanda y, tal vez en conjunto con alguna manipulación manual, asuma una forma sustancialmente cilíndrica coaxial con el barreno 30. Como se ilustra en las Figuras 4 y 5, una de las superficies opuestas 18 de la hoja forma una superficie externa, orientada hacia afuera que enfrenta una superficie sustancialmente cilíndrica 32 orientada hacia adentro del barreno 30.

[0048] Aunque las figuras ilustran la hoja 20 estando conformada en forma cónica para inserción dentro del barreno 30, debe apreciarse que la hoja 20 puede estar conformada en una forma sustancialmente cilíndrica que define un pasaje longitudinal que se extiende entre los extremos longitudinalmente opuestos 11, 12 del mismo. Los diámetros de los extremos 11, 12 pueden ser sustancialmente los mismos antes de la inserción de uno de los extremos 11, 12 dentro del extremo abierto 33 del barreno 30. Cuando la hoja 20 es liberada puede ya ser sustancialmente cilíndrica y coaxial con la superficie sustancialmente cilíndrica 32 del barreno 30. Las propiedades resilientes del material a partir del cual está formada la hoja 20 hacen que la superficie externa 18 tienda a estar contra la superficie interna 32 del barreno 30.

[0049] Como se ilustra en la Figura 4, la hoja 20 se sitúa dentro del extremo abierto 33 del barreno 30 y forma una barrera que evita que fragmentos circundantes 40 de roca suelta caigan o colapsen dentro del barreno 30 en o cerca del extremo abierto 33 del barreno 30. Como la capa de fragmentos 40 de roca preacondicionados puede tener una profundidad de hasta cuatro o más metros, la hoja 20 ayuda a soportar la porción superior de la superficie interna 32 del barreno 30 para que no colapse. La dimensión longitudinal de la hoja 20 entre los bordes de extremo opuestos 22, 24 puede ser 1 metro, 1,5 metros, 2 metros, 2,5 metros, 3 metros, 3,5 metros, 4 metros o más en longitud o cualquier longitud entre ellas. La longitud de la hoja 20 es seleccionada en base a los requerimientos geológicos. Cuando está posicionada dentro del barreno 30, la hoja 20 provee soporte para la superficie interna 32 a través de una porción sustancial de la capa preacondicionada de fragmentos 40 de roca. La hoja 20 forma de este modo una barrera que evita que fragmentos circundantes 40 de roca sueltos, tal como dentro de la capa preacondicionada, caigan o colapsen dentro del barreno 30.

[0050] El ancho de la hoja 20 entre el par de bordes laterales paralelos 21, 23 es levemente menor que la circunferencia de la superficie cilíndrica 32 orientada hacia adentro del barreno 30. Cuando la hoja 20 asume la forma sustancialmente cilíndrica dentro del barreno 30 los bordes laterales 21, 23 de la hoja están separados y no se superponen. En la forma de realización de las

Figuras 1 a 5, las pestañas alargadas 25, 27 están separadas una pequeña distancia y están adaptadas para hacer tope entre sí para evitar que los bordes 21, 23 se deslicen por encima entre sí. Las pestañas alargadas 25, 27 evitan que la circunferencia de la hoja 20, en su forma cilíndrica dentro del barreno 30, disminuya por debajo de un umbral. Puesto de otro modo, las pestañas alargadas 25, 27 a lo largo de los bordes del panel 20 están adaptadas para hacer tope para soportar la estructura cilíndrica de la hoja 20 y, por lo tanto soportar la superficie cilíndrica externa 18 de la hoja 20 contra la superficie sustancialmente cilíndrica 32 orientada hacia adentro del barreno 30 y los fragmentos 40 de roca sueltos en o cerca del extremo abierto 33 del barreno 30.

[0051] Cada una de las aberturas 12, 13, 14, 15 se extiende a través de la hoja 20 desde la superficie externa 18 hasta la superficie interna 19. Un miembro de varilla alargado 50 puede ser insertado horizontalmente a través de un par de las aberturas 12, 14, o 13, 15 horizontalmente alineadas. Cada par de aberturas 12, 14, o 13, 15 horizontalmente alineadas están situadas en diferentes posiciones a lo largo de la longitud de la hoja 20 de modo de que un usuario pueda seleccionar una altura de la hoja 20 dentro del barreno 30. Los extremos opuestos del miembro de varilla 50 se acoplan a una superficie 55 que circunda el extremo abierto 33 del barreno 30. El miembro de varilla 50 acopla el par de aberturas 12,14 o 13, 15 horizontalmente alineadas y la superficie 55 circundante para evitar que la hoja 20 pase más allá dentro del extremo abierto 33 del barreno 30. Como se muestra en la Figura 4, una pequeña porción de la hoja sobresale del extremo abierto 33 del barreno 30. El miembro de varilla 50 funciona para anclar la hoja 20 en o hacia el extremo abierto 33 del barreno 30.

[0052] La Figura 6 ilustra otra forma de realización del aparato 100 la cual es similar a las formas de realización de las Figuras 1 a 5 y funciona de una manera similar. Las características del aparato de la Figura 6 que son estructural o funcionalmente similares, o son las mismas que las características de las formas de realización de las Figuras 1 a 5 están representadas mediante similares números de referencia. El aparato 100 incluye una hoja flexible 20,

que preferiblemente comprende una hoja de material resiliente tal como un material polimérico resiliestamente flexible. Que también puede estar reforzado. La hoja 20 incluye un par de superficies opuestas 18, 19 y está preferiblemente conformada en una forma rectangular de modo que incluye un primer par de bordes laterales paralelos 21, 23 separados y transversalmente opuestos que se extienden longitudinalmente y un segundo par de bordes de extremo paralelos 22, 24 separados y longitudinalmente opuestos que se extienden transversalmente. A diferencia de la forma de realización de las Figuras 1 a 5, la forma de realización de la Figura 6 no tiene pestañas alargadas a lo largo del primer par de bordes laterales paralelos 21, 23. Debe apreciarse que los pares de bordes 21,23, 22,24 no necesitan ser paralelos. La hoja 20 incluye una serie de aberturas 12, 13, 14, 15 que están dispuestas en pares 12, 14 y 13, 15 separados lateralmente y alineados longitudinalmente. La hoja 20 incluye varias aberturas 16 que actúan como asas o manijas que permiten a un usuario manipular la hoja 20 desde una condición plana, como se ilustra en la Figura 6, a una condición cónica o cilíndrica como se ilustra en las Figuras 3, 4 y 5. Las aberturas 16 actúan como una manija que permite a un usuario maniobrar la hoja 20 hacia adentro y hacia afuera o en relación con el extremo abierto 33 del barreno 30.

[0053] A pesar de que en la forma de realización del aparato 100 de la Figura 6 el ancho de la hoja 20 entre los bordes laterales 21, 23 que se extienden longitudinalmente es menor que la circunferencia del barreno 30, debe apreciarse que en otras formas de realización el ancho puede ser igual a, o mayor que la circunferencia del barreno 30.

[0054] Las Figuras 7 y 8 ilustran otra forma de realización del aparato 200 la cual es similar a las formas de realización de las Figuras 1 a 6 y funciona de una manera similar. Las características del aparato de las Figuras 7 y 8 que son similares o iguales a las características de la forma de realización de las Figuras 1 a 6 están representadas mediante similares números de referencia. El aparato 200 incluye una hoja flexible 20, que comprende una hoja de material resiliente tal como un material polimérico resiliestamente flexible que está reforzado. La hoja 20 incluye un par de superficies opuestas 18, 19 y está

conformada en una forma rectangular de modo que incluye un primer par de bordes laterales paralelos 21, 23 separados y transversalmente opuestos y un segundo par de bordes de extremo paralelos 22, 24 separados y longitudinalmente opuestos. A diferencia de la forma de realización de la Figura 6, en la forma de realización de las Figuras 7 y 8 los bordes laterales paralelos 21, 23 transversalmente opuestos están ahusados en los extremos 21a, 23a de los mismos. El ahusamiento de los extremos 21a, 23a de los bordes laterales paralelos 21, 23 transversalmente opuestos reduce el acampanado de las esquinas de la hoja 20 cuando la hoja 20 es forzada, ya sea manualmente o de otra manera, a una forma curvada, tal como una forma cilíndrica como se ilustra en la Figura 8. Por consiguiente, cuando la hoja 20 es doblada sobre sí misma y los bordes paralelos 21, 23 transversalmente opuestos son llevados acercándolos entre sí, el ahusamiento de los extremos 21a, 23a de los bordes paralelos 21, 23 transversalmente opuestos promueve una forma cilíndrica más uniforme para la hoja 20. El extremo distal de la hoja 20 que comprende los extremos ahusados 21a, 23a está adaptado para ser insertado dentro del barreno 30. La minimización del acampanado hacia afuera de las esquinas de la hoja 20 en el extremo distal de la misma en donde los bordes paralelos 21, 23 transversalmente opuestos y los bordes paralelos 22, 24 longitudinalmente opuestos se encuentran, ayuda en la facilidad de inserción de la hoja 20 dentro del barreno 30.

[0055] En otro aspecto, la invención provee un método para evitar que fragmentos 40 de roca sueltos caigan o colapsen dentro del barreno 30. El método incluye una etapa de doblar, tal como forzar en forma manual o de otra manera una hoja 20 resilientemente flexible, tal como la hoja 20 de la Figura 2 o de la Figura 6, en una forma sustancialmente cilíndrica o forma cónica que se ahúsa en una dirección axial desde un extremo de diámetro mayor hasta un extremo de diámetro menor, tal como se ilustra en la Figura 3. El método incluye insertar un extremo de la hoja 20, el cual puede ser el extremo de diámetro menor, a través del extremo abierto de un barreno 30, tal como se muestra en la Figura 3. La hoja 20 es luego liberada, o puede ser manipulada, para asumir una forma sustancialmente cilíndrica coaxial con el barreno 30 como se ilustra en la Figura 4. La hoja 20 forma de este modo una barrera que

evita que los fragmentos circundantes de roca suelta caigan o colapsen dentro del barreno 30 en, o cerca del extremo abierto del barreno 30.

[0056] En otro aspecto, la invención provee un método de voladura en banco. El método incluye taladrar barrenos a través de una capa de fragmentos 40 de roca suelta preacondicionados y dentro de la roca estable por debajo. La capa preacondicionada 40 puede ser de hasta 4 metros o más en profundidad. El método incluye conformar una hoja 20 flexible sustancialmente plana, tal como la hoja 20 de la Figura 2 o de la Figura 6, en una forma curvada que define un pasaje longitudinal que se extiende entre aberturas en extremos longitudinalmente opuestos. El método incluye además insertar un extremo de la hoja 20 curvada dentro de un extremo abierto del barreno 30 mediante lo cual la hoja 20 curvada enfrenta estrechamente una superficie interna 32 del barreno 30 dentro de la capa de fragmentos 40 de roca suelta preacondicionados y forma una barrera que evita que la superficie interna 32 del barreno 30 dentro de la capa preacondicionada de fragmentos 40 de roca suelta caiga o colapse dentro del barreno 30.

[0057] Los métodos pueden incluir forzar la hoja flexible 20 en una forma cónica que se ahúsa en una dirección axial desde una abertura de mayor diámetro en uno de los extremos hasta una abertura de menor diámetro en el otro extremo, insertar el extremo de menor diámetro a través del extremo abierto del barreno 30 y liberar la hoja 20 para que asuma una forma sustancialmente cilíndrica dentro del barreno 30. Alternativamente, el método puede involucrar forzar la hoja flexible 20 en una forma sustancialmente cilíndrica e insertar un extremo a través del extremo abierto del barreno 30 hacia abajo hasta una profundidad deseada. Una varilla alargada 50 puede entonces ser insertada a través de las aberturas 12, 14, 13, 15 dentro de la hoja 20. La varilla alargada 50 acopla la superficie circundante al barreno 30, como se ilustra en la Figura 3, para mantener la hoja 20 en la abertura dentro del barreno.

[0058] Preferiblemente, la hoja 20 tiene una dimensión de largo longitudinal que es 1 metro, 1,5 metros, 2 metros, 2,5 metros, 3 metros, 3,5 metros, 4

metros o más o cualquier longitud entre ellas. La longitud de la hoja 20 es seleccionada en base a requerimientos geológicos. Preferiblemente, los métodos incluyen insertar la hoja 20 curvada dentro del extremo abierto del barreno 30 mediante lo cual la hoja 20 curvada enfrenta estrechamente una superficie interna 32 del barreno 30 hacia abajo a una profundidad de aproximadamente 1 metro, aproximadamente 1,5 metros, aproximadamente 2 metros, aproximadamente 2,5 metros, aproximadamente 3 metros, aproximadamente 3,5 metros, aproximadamente 4 metros o más o cualquier profundidad entre ellas dentro de la capa de fragmentos 40 de roca sueltos preacondicionados.

[0059] La hoja 20 puede permanecer en posición dentro del barreno 30 durante una etapa subsiguiente de depósito de explosivos y otros consumibles dentro del barreno 30. En formas de realización de los métodos, la hoja 20 puede permanecer en la forma cilíndrica o puede ser manipulada en una forma cónica, tal como doblando la hoja 20 en forma cónica, como se ilustra en la Figura 3, de modo que la hoja 20 puede operar como un embudo a través del cual pueden depositarse explosivos y otros consumibles dentro del barreno 30.

[0060] En formas de realización de los métodos, el usuario selecciona una altura deseada para la hoja 20 que es situada dentro del barreno 30 mediante la ubicación del miembro de varilla alargado 50 a través de un par deseado de aberturas 12, 14, 13, 15. Después que la hoja 20 es insertada dentro del barreno 30 el miembro de varilla alargado 50 permanece sobre la superficie 55 circundante al barreno 30. Las aberturas 12, 14, 13, 15 están posicionadas de modo que con la inserción de la varilla alargada 50 a través de las mismas, la varilla alargada 50 está desplazada del eje central del pasaje longitudinal que se extiende a través de la hoja 20 curvada para facilitar la inserción dentro del barreno 30 de material de revestimiento, la carga con un explosivo, detonador y provisión de cualquier otro consumible dentro del barreno 30. La hoja 20 puede luego ser parcialmente retirada y conformada en forma de embudo antes de depositar material “contenedor” dentro del barreno 30. La hoja 20 puede ser retirada del barreno 30 para asumir una forma plana para almacenamiento.

[0061] La Figura 9 ilustra un dispositivo de despliegue 300 para desplegar la hoja 20 dentro del barreno 30. El dispositivo 300 incluye un aparato conformador 310 adaptado para conformar la hoja flexible plana 20 en una forma curvada para inserción dentro del extremo abierto del barreno 30 mediante lo cual la hoja curvada enfrenta estrechamente la superficie interna del barreno 30 y forma una barrera que evita que fragmentos de roca sueltos circundantes caigan o colapsen dentro del barreno 30.

[0062] El dispositivo de despliegue 300 incluye una pluralidad de hojas 20 de la Figura 6 dispuestas en una pila 315. El dispositivo 300 incluye un recolector 320 y alimentador 325 de hojas que es operable para recoger una hoja 20 individual desde la pila 315 y alimentar la hoja 20 a un aparato conformador 330 vertical. En una forma de realización ilustrada en la Figura 9, el recolector 320 y el alimentador 325 comprenden una disposición de cintas accionadas operables para recoger una de las hojas 20 a la vez desde la pila 315. Sin embargo, cualquier disposición mecánica que esté adaptada para recoger una hoja 20 de la pila 315 y alimentar la hoja 20 al aparato conformador 330 vertical puede constituir otra forma de realización de la invención. El aparato conformador 330 es operable para conformar la hoja 20 en una forma curva que define un pasaje longitudinal que se extiende entre aberturas en extremos longitudinalmente opuestos. El aparato conformador 330 incluye un pasaje 332 con forma, verticalmente orientado con una amplia abertura en la parte superior 334 y paredes laterales que se ahúsan hacia una salida inferior 336 más estrecha. Sin embargo, cualquier disposición mecánica que esté adaptada para conformar la hoja 20 en una forma curvada que defina un pasaje longitudinal que se extiende entre aberturas en extremos longitudinalmente opuestos puede constituir otra forma de realización de la invención.

[0063] La salida 336 del aparato conformador 330 está adaptada para ser situada manual o automáticamente sobre o hasta cierto grado dentro del extremo abierto del barreno 30. El recolector 320 y alimentador 325 de hojas son operables para impulsar la hoja 20 recogida individualmente a través del pasaje 332 y a través de la salida para de ese modo alimentar la hoja 20 curvada dentro del extremo abierto del barreno 30. El aparato conformador 330

es operable para alimentar continuamente la hojas 20 hasta una profundidad deseada dentro del barreno 30 y liberar la hoja 20 cuando ha alcanzado una profundidad predeterminada. La hoja 20 liberada, que tiene una forma sustancialmente cilíndrica coaxial con el barreno 30 como en la Figura 4, forma de este modo una barrera que evita que fragmentos de roca sueltos circundantes caigan o colapsen dentro del barreno 30.

[0064] El dispositivo de despliegue 300 puede estar montado en un vehículo (no mostrado) o un remolque (no mostrado) acoplado a un vehículo o cualquier otro aparato móvil adaptado para ser maniobrado alrededor de un sitio que comprende una pluralidad de barrenos 30 que han sido previamente taladrados. El vehículo u otro aparato móvil puede ser un camión que es operable manualmente mediante un conductor o en una forma de realización está configurado para operar autónomamente o semiautónomamente. El vehículo u otro aparato móvil puede comprender un módulo de control que incluye un dispositivo de ubicación GPS y está adaptado para controlar un medio de impulsión y medios de direccionamiento del vehículo. El módulo de control está adaptado para recibir o ser programado con las coordenadas de la ubicación de uno o más de una pluralidad de barrenos y para maniobrar autónomamente el dispositivo de despliegue 300 hasta una ubicación adyacente al primero de los barrenos.

[0065] Cuando se ubica adyacente al primer barreno 30, el módulo de control puede operar autónomamente el dispositivo de despliegue 300 para desplegar una de las hojas 20 dentro del barreno 30. El módulo de control puede hacer que la salida del dispositivo de despliegue 300 se ubique sobre el barreno utilizando las coordenadas del barreno o utilizando imágenes desde una cámara montada en el dispositivo 300 o en el vehículo 350 o una combinación de ambas. El módulo de control puede activar autónomamente o semiautónomamente el recolector 320 y alimentador 325 de hojas para impulsar la hoja 20 a través del aparato conformador 330 y a través de la salida 336 para alimentar de este modo la hoja 20 curvada dentro del extremo abierto del barreno 30.

[0066] El módulo de control puede hacer que el dispositivo de despliegue 300, vehículo, remolque u otro aparato móvil maniobre autónomamente hasta una ubicación adyacente al siguiente barreno para subsiguiente despliegue autónomo o semiautónomo de una hoja 20. El módulo de control puede hacer que la plataforma lleve a cabo autónomamente o semiautónomamente el despliegue de hojas a través de un conjunto de barrenos.

[0067] Aunque la descripción fue realizada con referencia a ejemplos específicos, aquellos expertos en el arte apreciarán que la descripción puede ser llevada a la práctica en muchas otras formas, manteniendo los amplios principios y el espíritu de la descripción anterior.

REIVINDICACIONES

1. Un aparato para evitar que fragmentos de roca sueltos circundantes caigan o colapsen dentro de un barreno, incluyendo el aparato:

una hoja resiliestamente flexible que incluye un par de bordes laterales separados que se extienden longitudinalmente y un par de bordes de extremo separados que se extienden lateralmente, teniendo la hoja una forma curvada que define un pasaje longitudinal que se extiende entre aberturas en extremos longitudinalmente opuestos, siendo un extremo de la hoja curvada insertable dentro del extremo abierto de un barreno mediante lo cual en la forma curvada los extremos laterales de la hoja están libres y la hoja se inclina hacia una forma plana mediante lo cual una superficie externa de la hoja curvada se inclina contra una superficie interna del barreno y forma una barrera que evita que los fragmentos circundantes de roca sueltos caigan o colapsen dentro del extremo abierto del barreno.

2. El aparato de la reivindicación 1, en donde la hoja está adaptada para ser forzada en forma sustancialmente cilíndrica o cónica en donde con la inserción a través del extremo abierto de un barreno la hoja asume una forma sustancialmente cilíndrica coaxialmente dentro del barreno.

3. El aparato de la reivindicación 1 o la reivindicación 2, en donde el ancho de la hoja entre los bordes laterales que se extienden longitudinalmente es menor que la circunferencia del barreno, igual a la circunferencia del barreno o mayor que la circunferencia del barreno.

4. El aparato de una cualquiera de las reivindicaciones 1 a 3, en donde los bordes laterales que se extienden longitudinalmente se ahúsan en un extremo de los mismos para promover una forma cilíndrica más uniforme de la hoja.

5. El aparato de una cualquiera de las reivindicaciones 1 a 4, en donde la hoja comprende una hoja normalmente plana de material flexible.

6. El aparato de una cualquiera de las reivindicaciones 1 a 5, en donde la hoja incluye aberturas que están adaptadas para recibir a través de las mismas un miembro alargado para acoplarse a una superficie circundante al barreno para evitar la inserción adicional de la hoja a través de la abertura del barreno

7. El aparato de una cualquiera de las reivindicaciones 1 a 6, en donde la hoja incluye al menos una abertura a través de la hoja adyacente a cada borde lateral que se extiende longitudinalmente operable como una manija para que un usuario enrolle manualmente la hoja en una forma curvada.

8. El aparato de una cualquiera de las reivindicaciones 1 a 7, en donde la hoja incluye al menos una abertura a través de la hoja adyacente a uno de los bordes de extremo operable como una manija para que un usuario inserte y retire manualmente la hoja en relación con el extremo abierto de un barreno.

9. Un método para evitar que fragmentos circundantes de roca sueltos caigan o colapsen dentro de un barreno, incluyendo el método:

proveer una hoja resilientemente flexible que incluye un par de bordes laterales separados que se extienden longitudinalmente y un par de bordes de extremo separados que se extienden lateralmente, conformar la hoja en una forma curvada que define un pasaje longitudinal que se extiende entre aberturas en extremos opuestos longitudinalmente,

insertar un extremo de la hoja curvada dentro del extremo abierto de un barreno mediante lo cual en la forma curvada los extremos laterales de la hoja están libres y la hoja se inclina hacia una forma plana mediante lo cual una superficie externa de la hoja curvada se inclina contra una superficie interna del barreno sustancialmente de manera coaxial formando con ello una barrera que evita que los fragmentos circundantes de roca sueltos caigan o colapsen dentro del barreno.

10. El método de la reivindicación 9, que incluye además:

forzar la hoja flexible en una forma cilíndrica o cónica,

insertar un extremo a través del extremo abierto de un barreno, y

liberar la hoja para que asuma una forma sustancialmente cilíndrica coaxial con el barreno para formar una barrera que evita que fragmentos circundantes de roca sueltos caigan dentro del extremo abierto del barreno.

11. El método de la reivindicación 9 o la reivindicación 10, incluyendo insertar un miembro alargado a través de aberturas en la hoja, mediante lo cual

el miembro alargado se acopla a una superficie que rodea el barreno para evitar una mayor inserción de la hoja a través del extremo abierto del barreno.

12. Un método de voladura en banco que incluye:

perforar barrenos a través de una capa de fragmentos de roca sueltos preacondicionados y dentro de la roca estable por debajo;

conformar una hoja resiliientemente flexible sustancialmente plana en una forma curvada que define un pasaje longitudinal que se extiende entre aberturas en extremos longitudinalmente opuestos;

insertar un extremo de la hoja curvada dentro de un extremo abierto del barreno mediante lo cual en la forma curvada los extremos laterales de la hoja están libres y la hoja resiliente se inclina hacia una forma plana mediante lo cual la superficie externa la hoja curvada se inclina contra una superficie interna del barreno dentro de la capa de fragmentos de roca sueltos preacondicionados formando una barrera que evita que la superficie interna del barreno dentro de la capa preacondicionada caiga o colapse dentro del barreno.

13. El método de la reivindicación 12 que incluye: forzar la hoja flexible en una forma cilíndrica o cónica; insertar la hoja a través del extremo abierto de un barreno; y liberar la hoja para que asuma una forma sustancialmente cilíndrica dentro del barreno.

14. El método de la reivindicación 12 o reivindicación 13, en donde la hoja tiene una dimensión de largo longitudinal que es de 1 metro, 1,5 metros, 2 metros, 2,5 metros o cualquier longitud entre ellas.

15. El método de una cualquiera de las reivindicaciones 12 a 14, en donde la hoja curvada es insertada dentro del extremo abierto del barreno mediante lo cual la hoja curvada enfrenta estrechamente una superficie interna del barreno hacia abajo hasta una profundidad de aproximadamente 1 metro, aproximadamente 1,5 metros, aproximadamente 2 metros, aproximadamente 2,5 metros, o cualquier profundidad entre ellas dentro de la capa de fragmentos de roca sueltos preacondicionados.

16. Un dispositivo de despliegue para desplegar dentro de un barreno un aparato para evitar que fragmentos circundantes de roca sueltos caigan o colapsen dentro del barreno, incluyendo el dispositivo un aparato conformador adaptado para conformar una hoja flexible plana en una forma curvada para inserción dentro del extremo abierto de un barreno mediante lo cual la hoja curvada enfrenta estrechamente una superficie interna del barreno formando una barrera que evita que fragmentos circundantes de roca sueltos caigan o colapsen dentro del barreno

17. El dispositivo de la reivindicación 16, en donde el aparato conformador incluye un pasaje con forma adaptado para conformar la hoja en una forma curvada a medida que la hoja se mueve a través del pasaje.

18. El dispositivo de la reivindicación 17, en donde el pasaje con forma incluye una amplia abertura en la parte superior y paredes laterales que se ahúsan hacia una salida inferior más estrecha.

19. El dispositivo de una cualquiera de las reivindicaciones 16 a 18, en donde el dispositivo de despliegue incluye un almacenamiento de una pluralidad de hojas dispuestas en forma de pila.

20. El dispositivo de la reivindicación 19, que incluye un recolector y alimentador de hojas que es operable para recoger una hoja individual desde la pila y alimentar la hoja a través del pasaje con forma.

RESUMEN

La invención provee un aparato y método para evitar que fragmentos circundantes de roca sueltos caigan o colapsen dentro de un barreno. El aparato incluye una hoja flexible que incluye un par de bordes laterales separados que se extienden longitudinalmente y un par de bordes de extremo separados que se extienden lateralmente. La hoja tiene una forma curvada que define un pasaje longitudinal que se extiende entre aberturas en extremos longitudinalmente opuestos, siendo un extremo de la hoja curvada insertable dentro del extremo abierto de un barreno mediante lo cual la hoja curvada enfrenta estrechamente una superficie interna del barreno y forma una barrera que evita que los fragmentos circundantes de roca sueltos caigan o colapsen dentro del barreno. La invención también provee un método de voladura en banco y un dispositivo de despliegue para desplegar el aparato dentro de un barreno.