(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
21 September 2023 (21.09.2023)

WIPO | PCT

(10) International Publication Number
WO 2023/173168 A1

(51) International Patent Classification:
F42B 3/087 (2006.01) *F42D 1/22* (2006.01)
F42D 1/08 (2006.01)

(21) International Application Number:
PCT/AU2023/050181

(22) International Filing Date:
15 March 2023 (15.03.2023)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
2022900631 15 March 2022 (15.03.2022) AU

(71) Applicant: **AQUIRIAN TECHNOLOGY PTY LTD** [AU/AU]; Level 3, 190 St. Georges Terrace, Perth, Western Australia 6000 (AU).

(72) Inventors: **PATCHING, Gregory**; Level 3, 190 St. Georges Terrace, Perth, Western Australia 6000 (AU). **WRIGHT, Jonathan**; Level 3, 190 St. Georges Terrace, Perth, Western Australia 6000 (AU).

(74) Agent: **GESTALT LAW PTY LTD**; Level 1, 98 Riley Street, Darlinghurst, New South Wales 2010 (AU).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CV, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IQ, IR, IS, IT, JM, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, MG, MK, MN, MU, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, CV, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SC, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, ME, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

(54) Title: A METHOD AND APPARATUS FOR DEPLOYING A LINING FOR EXPLOSIVES INTO A BLAST HOLE

(57) Abstract: The present invention relates to apparatus and methods for lining a blast hole including a sub-surface void or cavity. The apparatus includes a tube member comprising a wall having an inwardly facing surface and an outwardly facing surface, the inwardly facing surface defining a longitudinal passage that is open at longitudinally opposite ends. A length of a flexible tubular liner is gathered relative to the tube member and the apparatus is locatable within the open end of a blast hole whereby the flexible liner is adapted to be drawn from the tube member and filled within the blast hole with bulk explosive material provided through the longitudinal passage of the tube member.

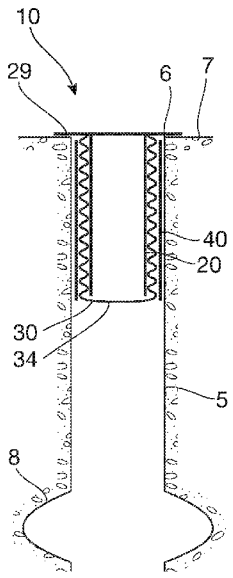

Figure 4

WO 2023/173168 A1

[Continued on next page]

Published:

— *with international search report (Art. 21(3))*

— *in black and white; the international application as filed contained color or greyscale and is available for download from PATENTSCOPE*

A METHOD AND APPARATUS FOR DEPLOYING A LINING FOR EXPLOSIVES INTO A BLAST HOLE

TECHNICAL FIELD

[001] The present invention relates to the field of blasting, particularly in the fields of mining, quarrying and excavations. In particular, the invention relates to methods and apparatus for use in blasting operations in mining, quarrying and excavations.

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.

[003] In any mining operation, and in large open cut mines, efficient use of materials and labour is critically important for safety, commercial viability and profitability. Blasting operations in large open cut mines can often involve the drilling of many blast holes, in the order of a hundred or more at a time, in diameters as large as 270 to 311 millimetres and to depths of as much as 20 metres or more. These blast holes are filled with bulk explosive materials such as ANFO or emulsion explosives. The bulk explosive material deposited into each blast hole is contacted with an explosive initiator, such as a detonator and a booster, and covered or “stemmed” with material such as aggregate. The initiator is activated electrically, non-electrically or by some other means to initiate or cause the bulk explosive material to detonate.

[004] Some blast holes are drilled into challenging geologies such as uneven terrain or geologies comprising sub-surface voids or cavities in the bedrock. When filling blast holes that have been drilled into geology comprising subsurface voids with bulk explosive material, the explosive material will fill the geological voids. As a result, some of the explosive material spreads out from

the blast hole column and into these voids and is not contained in a column of predetermined diameter and height according to the blast design. Such uncontained explosive material due to uncontrolled spreading of explosive from the column is not desirable.

[005] The amount of bulk explosive material required and the dimensions of the explosive charge (i.e. diameter and height) are carefully calculated for each blast hole during the blast design process. Uncontrolled spreading of uncontained explosive into geological voids can result in uncontrolled blast wave propagation and undesired outcomes of the blasting operation.

[006] Furthermore, many man-hours are involved in preparing blast holes, filling them with bulk explosive and stemming the blast holes. Additionally, a variety of different pieces of equipment may be manoeuvred around the blast holes to perform the process of preparing blast holes, filling them with explosive and stemming the blast holes. It is desirable to perform the required sequence of tasks in a manner that is time and labour efficient.

[007] One solution that ameliorates the problem of uncontained explosive material in blast holes drilled into geology comprising sub-surface voids is to use a liner material. The liner material is an elongated tube that is typically fed from a roll, cut to length and sealed at one end before the sealed end is fed down into the blast hole. The liner is primed and filled with the bulk explosive material and then pulled to the side of the hole and then the hole is stemmed. However, the use of a liner involves an additional sequence of steps to the blasting process and requires that additional material and equipment be deployed to the blasting site. Furthermore, the deployment of a liner into a blast hole in challenging or uneven terrain can be time consuming and dangerous.

[008] Accordingly, there exists a need for an efficient and convenient means for ameliorating the problem of uncontained bulk explosives in blast holes drilled in geology comprising sub-surface voids.

[009] 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

[0010] Accordingly, in one aspect, the invention provides an apparatus for lining a blast hole, the apparatus including:

a tube member comprising a wall having an inwardly facing surface and an outwardly facing surface, the inwardly facing surface defining a longitudinal passage that is open at longitudinally opposite ends;

a length of a flexible tubular liner gathered relative to the tube member;

wherein the apparatus is locatable within the open end of a blast hole and the flexible liner is adapted to be drawn from the tube member and filled within the blast hole with bulk explosive material provided through the longitudinal passage of the tube member.

[0011] Embodiments of the invention provide a self-contained apparatus that is readily deployable into a blast hole that includes a length of flexible liner for containing a full load of bulk explosive material within the blast hole. Embodiments of the invention are advantageous as they enable loading of blast holes with a predetermined amount of bulk explosive material and without uncontrolled spreading out of the bulk explosive material from the column of the blast hole.

[0012] Preferably, the apparatus is self-retaining within the blast hole at or near the level of a surface surrounding the open end of the blast hole.

[0013] Preferably, the tube member includes an outwardly extending part for engaging the open end of the blast hole for retaining the apparatus at or near the level of the surrounding surface.

[0014] Preferably, the outwardly extending part includes a flange extending outwardly from an end of the tube member.

[0015] Preferably, the flange is a planar member.

[0016] In embodiments, the outwardly extending part includes an enlargement of the tube member, wherein the enlargement has an external diameter that is greater than the diameter of the open end of the blast hole, whereby the enlargement is wedged into the open end of the blast hole.

[0017] Preferably, the enlargement of the tube member comprises a conically shaped portion of the tube member.

[0018] Preferably, the wall of the tube member is rigid.

[0019] Preferably, the wall of the tube member is formed out of a rigid plastic material or a rigid paper material or a rigid cardboard material.

[0020] Preferably, at least part of the wall of the tube member is cylindrical.

[0021] Preferably, at least part of the wall of the tube member tapers from a portion having a relatively wider diameter to a portion having a relatively smaller diameter.

[0022] Preferably, at least part of the wall of the tube member has a polygonal cross section.

[0023] Preferably, the tube member is an inner tube member and the flexible tubular liner is gathered on the outwardly facing surface of the inner tube member.

[0024] In embodiments, the apparatus further includes an outer tube member covering the flexible tubular liner gathered on the inner tube member.

[0025] Preferably, the outer tube member comprises a wall having an inwardly facing surface and an outwardly facing surface, the inwardly facing surface defining a longitudinal passage that is open at longitudinally opposite ends.

[0026] Preferably, the inwardly facing surface of the outer tube member has a larger diameter than the outwardly facing surface of the inner tube member.

[0027] Preferably, the diameter of the inwardly facing surface of the outer tube member is sized to provide clearance for the flexible tubular liner gathered on the outwardly facing surface of the inner tube member.

[0028] Preferably, the inwardly facing surface of the outer tube member has a larger diameter upper portion and a relatively smaller diameter lower portion, wherein the larger diameter upper portion is adapted to provide clearance for the flexible tubular liner gathered on the outwardly facing surface of the inner tube member.

[0029] Preferably, the diameter of the inwardly facing surface of the outer tube member is 5cm, or 10cm, or 15cm, or 20cm larger than the diameter of the outwardly facing surface of the inner tube member or any increment therebetween.

[0030] Preferably, the wall of the outer tube member is rigid.

[0031] Preferably, the wall of the outer tube member is formed out of a plastic material or a rigid paper material or a cardboard material.

[0032] Preferably, the wall of the outer tube member is cylindrical.

[0033] Preferably, one end of the flexible liner is sealed and an opposite end of the flexible liner is connected to the inner tube member or to the outer tube member.

[0034] Preferably, the flexible liner is connected to an upper end of the inner tube member or the outer tube member located in use at or near the level of a surface surrounding the open end of the blast hole.

[0035] Preferably, the flexible liner is fastened to the inner tube member.

[0036] Preferably, the flexible liner is fastened to the outer tube member.

[0037] In embodiments, the length of the flexible tubular liner is gathered on the inwardly facing surface of the outer tube member.

[0038] Preferably, an insert is located within the upper end of the inner tube member in an interference fit to thereby retain the flexible liner at or near the level of a surface surrounding the open end of the blast hole.

[0039] Preferably, the flexible liner is comprised of a polymeric tubing, such as low density polyethylene or woven polypropylene.

[0040] Preferably, the flexible liner is a concertinaed or a bunched length of the flexible tubing disposed around the outwardly facing surface of the inner tube member.

[0041] Preferably, the flexible liner is adapted to be drawn from the bottom end of the inner tube member upon filling the flexible liner with the bulk explosive material.

[0042] Preferably, the flexible liner is of a length at least equal to the total depth of the blast hole.

[0043] In yet another aspect, the invention provides an apparatus for lining a blast hole, the apparatus including:
a tube member comprising a wall having an inwardly facing surface and an outwardly facing surface, the inwardly facing surface defining a longitudinal passage that is open at longitudinally opposite ends;
a length of a flexible tubular liner gathered on the outwardly facing surface of

the tube member;
wherein the apparatus is locatable within the open end of a blast hole for bulk explosive material to be provided through the longitudinal passage of the tube member to thereby fill the tubular liner with explosive material within the blast hole. Embodiments of this aspect of the invention include any one or more of the features of the embodiments of the first aspect described above.

[0044] In still yet another aspect, the invention provides an apparatus for lining a blast hole, the apparatus including:
a tube member comprising a wall having an inwardly facing surface and an outwardly facing surface, the inwardly facing surface defining a longitudinal passage that is open at longitudinally opposite ends;
a length of a flexible tubular liner gathered on the inwardly facing surface of the tube member;
wherein the apparatus is locatable within the open end of a blast hole for bulk explosive material to be provided within a longitudinal passage of the tubular liner to thereby fill the tubular liner with explosive material within the blast hole. Embodiments of this aspect of the invention include any one or more of the features of the embodiments of the first aspect described above

[0045] In another aspect, the invention provides a method for loading bulk explosives into a blast hole, the method including:
locating an apparatus in the open end of a blast hole including a tube member having a length of a flexible tubular liner gathered relative to the inner tube member;
providing bulk explosive material through a longitudinal passage of the inner tube member to thereby fill the tubular liner with explosive material within the blast hole, wherein the flexible liner is adapted to be drawn from the tube member upon filling the flexible liner with the bulk explosive material.

[0046] Preferably, locating the apparatus in the open end of a blast hole includes placing an outwardly extending protrusion of the tube member on a surface surrounding the open end of the blast hole thereby retaining the apparatus at or near the level of the surrounding surface.

[0047] Preferably, the outwardly extending protrusion includes a flange extending outwardly from an end of the tube member.

[0048] Preferably, the method includes detaching the outwardly extending protrusion from the tube member after the blast hole is filled with the bulk explosive material.

[0049] In embodiments, the method includes gathering the flexible tubular liner on the outwardly facing surface of the tube member and covering the flexible tubular liner gathered on the outwardly facing surface of the tube member with an outer tube member.

[0050] Preferably, the method includes gathering the flexible tubular liner on the tube member by placing an open end of a length of a lay-flat tubular blast hole liner over the tube member and drawing a length of the liner onto the outwardly facing surface of the tube member.

[0051] Preferably, the method includes connecting the open end of the tubular liner to an upper end of the tube member and sealing closed the other end of the liner.

[0052] In an embodiment, the method includes sealing the liner at a location along the length of the liner.

[0053] Preferably, the method further includes placing an initiator in the flexible tubular liner and depositing an amount of stemming material into the blast hole.

[0054] In another aspect, the invention provides a deployment device for deploying an apparatus for lining a blast hole including an inner tube member and a length of a flexible tubular liner gathered relative to the inner tube member, the deployment device including:
a deployment mechanism mounted to a vehicle including a store of a plurality of the apparatus;

the deployment mechanism being operable to deploy one of the apparatus at a time from the store into the open end of a blast hole.

[0055] In an embodiment, the deployment device comprises a robotic mechanism mounted to a vehicle including the store of the apparatus.

[0056] Preferably, the robotic mechanism is configured to retrieve one apparatus at a time from the store and to lower the apparatus into the open end of a blast hole.

BRIEF DESCRIPTION OF THE FIGURES

[0057] The present invention will now be described in more detail with reference to preferred embodiments illustrated in the accompanying figures, wherein:

[0058] Figure 1 illustrates a side view of an apparatus for lining a blast hole including an inner tube member, a length of flexible liner gathered on the inner tube member and an outer tube member covering the flexible tubular liner.

[0059] Figure 2 illustrates the inner tube member of the apparatus of Figure 1;

[0060] Figure 3 illustrates the inner tube member and the length of flexible liner gathered on the inner tube member of the apparatus of Figure 1;

[0061] Figure 4 illustrates the apparatus of Figure 1 located in the open end of a blast hole and an outwardly extending protrusion of the inner tube member engaging the surface surrounding the open end of the blast hole for retaining the apparatus at or near the level of the surrounding surface;

[0062] Figure 5 illustrates the apparatus of Figure 1 located in the blast hole of Figure 4 wherein the flexible liner, which is sealed at the bottom, is being filled with bulk explosive material;

[0063] Figure 6 illustrates the apparatus of Figure 1 located in the blast hole of Figure 4 wherein the flexible liner is drawn from the end of the inner tube towards the bottom of the blast hole as the liner is being filled with bulk explosive material;

[0064] Figure 7 illustrates the apparatus of Figure 1 located in the blast hole of Figure 4 wherein the flexible liner is drawn from the end of the inner tube towards the bottom of the blast hole and the liner being completely filled with bulk explosive material up towards the level of the open end of the blast hole;

[0065] Figure 8 illustrates the apparatus of Figure 1 located in the blast hole of Figure 4 wherein the outwardly extending protrusion is detached from the inner tube member after the liner is filled with bulk explosive material;

[0066] Figure 9 illustrates a side view of an apparatus for lining a blast hole in accordance with an embodiment of the invention including an outer tube member, a length of flexible liner gathered within the outer tube member that covers the flexible tubular liner;

[0067] Figure 10 illustrates a side view of an apparatus for lining a blast hole in accordance with an embodiment of the invention including an enlargement of the inner tube member comprising a conically shaped portion of the inner tube member;

[0068] Figure 11 illustrates a side view of an apparatus for lining a blast hole in accordance with an embodiment of the invention including an enlargement of the outer tube member comprising a conically shaped portion of the outer tube member;

[0069] Figures 12 and 13 illustrate a side view and a plan view of an embodiment of the apparatus of Figure 1 located in the open end of a blast hole wherein the outwardly extending protrusion of the inner tube member includes a slot for receiving and retaining a lead line to which is attached a initiator that

is dropped down into the blast hole through the opening at the top end of the inner tube member; and

[0070] Figure 14 illustrates a deployment device for deploying the apparatus of any one of Figures 1 to 13 into a blast hole in accordance with an embodiment of the invention.

[0071] The invention will now be described in further detail with reference to the embodiments illustrated in the Figures.

DETAILED DESCRIPTION

[0072] Referring to Figures 1 to 3, there is shown an apparatus 10 for lining a blast hole 5 in accordance with an embodiment the invention. The apparatus 10 includes an inner tube member 20 comprising a wall 24 having an inwardly facing surface 25 and an outwardly facing surface 27. In the embodiments illustrated in the figures, at least part of the wall 24 of the inner tube member 20 is cylindrical in shape. The inwardly facing surface 25 defines a longitudinal passage 22 that is open at longitudinally opposite ends 21, 23.

[0073] The wall 24 of the inner tube member 20 is rigid. The wall 24 of the inner tube member 20 is formed out of a plastic material or a rigid paper material or a cardboard material. The inner tube member 20 has a length of 100cm, or 125cm, or 150cm, or 175cm, or any increment therebetween.

[0074] In embodiments, not illustrated in the Figures, at least part of the wall 24 of the inner tube member 20 tapers from a portion having a relatively wider diameter to a portion having a relatively smaller diameter. In embodiments, at least part of the wall of the tube member has a circular cross section or a polygonal cross section.

[0075] An outwardly extending part or protrusion 29 is attached to the inner tube member 20 at the upper end 21 thereof. The protrusion 29 is in the form of a substantially planar flange that extends transversely from the outer surface 27 of the inner tube member 20. The protrusion 29 is operable for engaging the

open end 6 of the blast hole 5 and/or a surface 7 surrounding the open end 6 of the blast hole 5 to thereby retain the apparatus 10 at or near the level of the surrounding surface 7.

[0076] In an alternative embodiment of the apparatus 110 illustrated in Figure 10, the outwardly extending part is comprised of an enlargement 129 of the inner tube member 20. The enlargement 129 has an external diameter that is greater than the diameter of the open end 6 of the blast hole 5. The enlargement 129 tapers from an upper relatively larger diameter portion to a lower relatively smaller diameter portion. In use, the enlargement 129 is wedged into the open end 6 of the blast hole 5 to thereby retain the apparatus 110 at or near the level of the surrounding surface 7. Preferably, the enlargement 129 of the inner tube member 20 comprises a conically shaped portion of the inner tube member 20.

[0077] A length of a flexible tubular liner 30 is gathered on the outwardly facing surface 27 of the inner tube member 20. In the embodiments of the apparatus 10, 110 of Figures 1 to 8 and Figure 10, an open end 32 of the flexible liner 30 is connected to the upper end 21 of the inner tube member 20. The flexible liner 30 is fastened to the inner tube member 20 by fasteners or an adhesive or by being clamped or fused thereto. Alternatively, an insert (not shown) is located within the upper end 21 of the inner tube member 20 in an interference fit to thereby retain the flexible liner 30 to the upper end 21 of the inner tube member 20 at or near the level of a surface 7 surrounding the open end 6 of the blast hole 5. In embodiments of the apparatus 210, 310 of Figures 9 and 11, the open end 32 of the flexible liner 30 is connected to the upper end 41 of the outer tube member 40. The flexible liner 30 is fastened to the outer tube member 20 by fasteners or an adhesive or by being clamped or fused thereto.

[0078] The flexible tubular liner 30 is comprised of a lay-flat tubular polymeric material. Suitable materials for the tubular liner 30 include low density polyethylene or woven polypropylene material. The liner 30 is gathered over the inner tube member 20 by drawing a length of the liner 30 onto the outwardly facing surface 27 of the inner tube member 20. The flexible liner 30 is thereby

concertinaed or bunched around the outwardly facing surface 27 of the inner tube member 20. The opposite end 34 of the liner 30 is sealed closed by being tied off with tie wire or by plastic welding (e.g. using heat or ultrasonic welding) or by other suitable means.

[0079] The flexible tubular liner 30 has a length of 10m, or 15m, or 20m, or 25m, or 30m, or 35m, or 40m, or 45m or 50m, or any increment therebetween. The length of the flexible liner 30 is of a length at least equal to the total depth of the blast hole 5.

[0080] The apparatus 10 includes an outer tube member 40 covering the flexible tubular liner 30 gathered on the inner tube member 20. The outer tube member 40 is comprised of a cylindrical member including a cylindrical wall 45 having an inwardly facing surface 42 and an outwardly facing surface 44. The inwardly facing surface 42 defines a longitudinal passage that is open at longitudinally opposite ends 41, 43.

[0081] The inwardly facing surface 42 of the outer tube member 40 has a larger diameter than the outwardly facing surface 27 of the inner tube member 20. The diameter of the inwardly facing surface 42 of the outer tube member 40 is sized to provide clearance for the flexible tubular liner 30 gathered on the outwardly facing surface 27 of the inner tube member 20. In exemplary embodiments, the diameter of the inwardly facing surface 42 of the outer tube member 40 is 5cm, or 10cm, or 15cm, or 20cm larger than the diameter of the outwardly facing surface 27 of the inner tube member 20 or any increment therebetween.

[0082] In the embodiments illustrated in Figures 1 and 4 to 12, the inwardly facing surface 42 of the outer tube member 40 is cylindrical with a constant diameter throughout the length thereof. In another embodiment (not shown) the inwardly facing surface 42 of the outer tube member 40 has a larger diameter upper portion and a relatively smaller diameter lower portion. The larger diameter upper portion is adapted to provide clearance for the flexible tubular liner 30 gathered or concertinaed on an upper portion of the outwardly

facing surface 27 of the inner tube member 20, whereas the flexible tubular liner 30 is not gathered or concertinaed on a lower portion of the outwardly facing surface 27 of the inner tube member 20. In an embodiment, the outer tube member 40 has a mushroom shaped profile wherein the flexible tubular liner 30 is gathered or concertinaed within the head of the mushroom shaped outer tuber member 40.

[0083] The wall 45 of the outer tube member 40 is rigid. In embodiments, the wall 45 of the outer tube member 40 is formed out of a rigid plastic material or a rigid paper material or a rigid cardboard material.

[0084] In an embodiment of the apparatus 210 illustrated in Figure 9, an outwardly extending part or protrusion 149 is attached to the outer tube member 40 at the upper end 41 thereof. The embodiment of Figure 9 may include or omit the inner tube member 20. The protrusion 149 is in the form of a substantially planar flange that extends transversely from the outer surface 44 of the wall 45 of the outer tube member 40. The protrusion 149 is operable for engaging the surface 7 surrounding the open end 6 of the blast hole 5 to thereby retain the apparatus 210 at or near the level of the surrounding surface 7.

[0085] In yet another embodiment of the apparatus 310, as illustrated in Figure 11, the outwardly extending part is comprised of an enlargement 159 of the outer tube member 40. The enlargement 159 has an external diameter that is greater than the diameter of the open end 6 of the blast hole 5. In use, the enlargement 159 is wedged into the open end 6 of the blast hole 5 to thereby retain the apparatus 310 at or near the level of the surrounding surface 7. Preferably, the enlargement 159 of the outer tube member 40 comprises a conically shaped portion of the outer tube member 40.

[0086] In an embodiment of the apparatus illustrated in Figure 3, the apparatus 10 does not include the outer tube member 40 and includes only the inner tube member 20 and the length of the flexible tubular liner 30 gathered on the outwardly facing surface of the inner tube member 20. The outwardly

extending protrusion 29 is attached to the inner tube member 20 at the upper end 21 thereof.

[0087] In another embodiment, at least part of the inner tube member 20 itself and/or at least part of the outer tube member 40 itself tapers from an upper relatively larger diameter portion to a lower relatively smaller diameter portion, wherein the wider diameter upper portion is wedged into the open end 6 of the blast hole 5 to thereby retain the apparatus 110 at or near the level of the surrounding surface 7. Embodiments in which a tapering wall of the inner tube member 20, the outer tube member 40, the enlargement 129 of the inner tube member 20 or the enlargement 159 of the outer tube member 40 are wedged into the open end 6 of the blast hole 5 are advantageous as they inherently allow some movement of the apparatus 10, 110, 210, 310 relative to the blast hole when the flexible tubular liner 30 is drawn therefrom and filled within the blast hole 5 with bulk explosive material. Embodiments allowing some relative movement of the apparatus 10, 110, 210, 310 relative to the blast hole provides a buffer for forces experienced by the apparatus 10, 110, 210, 310 when the flexible tubular liner 30 is drawn therefrom and filled within the blast hole 5 with bulk explosive material.

[0088] Referring to Figures 4 to 8, there is shown a method for loading bulk explosives into a blast hole 5. The blast hole 5 is comprised of a hollow column that is generally cylindrical in shape according to the diameter of the drill bit used to drill the blast hole 5. The blast hole 5 penetrates a sub-surface void or cavity 8 in the bedrock into which explosive material would spread in an uncontrolled manner upon loading the blast hole 5 with explosive material.

[0089] In an embodiment, the drill rig for drilling the blast hole 5 detects when the drill bit at the end of a drill string passes through a sub-surface void or cavity 8 in the bedrock. A data logging system of the drill rig logs data in relation to which blast holes 5 comprise a sub-surface void or cavity 8 in the bedrock. The data logging system preferably also logs data in relation to the characteristics of the void or cavity 8 including an estimated depth and dimension of the void or cavity 8. Blast holes 5 that meet certain criteria, such as comprising a sub-

surface void or cavity 8 in the bedrock and preferably wherein the void or cavity 8 meets predetermined depth and dimension criteria, are designated as requiring the use of the apparatus 20 according to embodiments of the method described herein.

[0090] Referring to Figure 1, the method includes locating the apparatus 20 described above and illustrated in Figure 1 in the open end 6 of a blast hole 5. The outward extending protrusion 29 engages the open end 6 of the blast hole 5 and/or the surface 7 surrounding the blast hole 5 to maintain the apparatus 10 at the open end 6 of the blast hole 5. Prior to charging with bulk explosive material, the operator provides an initiator 80 into the opening at the top end 21 of the inner tube member 20 as illustrated in Figure 12.

[0091] Referring to Figure 12, the initiator 80, which is preferably comprised of a detonator and a booster, are attached to the end of a lead line 84 which is dropped down through the opening at the top end 21 of the inner tube member 20. A length of the lead line 84 is fed into the blast hole 5 until the initiator 80 reaches an appropriate depth which is usually a distance of about one metre from the bottom of the blast hole 5.

[0092] Figure 13 illustrates an embodiment in which the outwardly extending protrusion 29 of the inner tube member 20 includes a slot 86 for receiving and retaining the lead line 84. In use, the lead line 84 can be wrapped one or more times around the periphery of the inner tube member 20 and inserted within the slot 86 to retain the lead line securely 84 to the open end 6 of the blast hole 5. In an alternative embodiment of the apparatus 210 illustrated in Figure 9, the slot 86 is provided in the outwardly extending part or protrusion 149 of the outer tube member 40. In use, the lead line 84 can be wrapped one or more times around the periphery of the outer tube member 40 and inserted within the slot 86 to retain the lead line securely 84 to the open end 6 of the blast hole 5. The slot 86 is advantageous as it enables secure retention of the lead line 84, with the initiator 80 attached thereto, to the outwardly extending part or protrusion 29, 129, 149, 159, 149 of the inner or outer tube member 20, 40 during

subsequent loading of the blast hole with explosive material and stemming material.

[0093] Referring to Figure 5, a bulk explosive material loading hose 50 is inserted into the opening at the top end 21 of the inner tube member 20 and explosive material 55 is gradually fed into the apparatus 10. The bulk explosive material 55, such as ANFO or an emulsion explosive, passes down through the longitudinal passage 22 of the inner tube member 20 to thereby fill the tubular liner 30 with the explosive material 55 within the blast hole 5.

[0094] In the embodiment illustrated in Figures 5 and 6, the explosive material 55 collects at the sealed end 34 of the liner 30 and as illustrated in Figure 6 draws the liner 30 from the bottom end 23 of the inner tube member 20. The sealed end 34 of the liner 30 reaches a bottom 8 of the blast hole 5 and as illustrated in Figure 7 continues to fill with the explosive material 55 until the liner 30 is filled up to a desired level. Usually the liner is filled to a level below the open end 6 of the blast hole 5 by a predetermined distance of say 1, 2 or more metres.

[0095] In another embodiment, the explosive loading hose 50 is inserted into the opening at the top end 21 of the inner tube member 20 and engages the sealed end 34 of the liner 30 and the weight of the explosive loading hose 50 draws the liner 30 from the bottom end 23 of the inner tube member 20. The explosive loading hose 50 is fed until the sealed end 34 of the liner 30 reaches the bottom 8 of the blast hole 5. The explosive material 55 is then pumped out through the explosive loading hose 50 into the tubular liner 30. As the tubular liner 30 is filed with the bulk explosive material 55, the explosive loading hose 50 is drawn upwards and out of the blast hole 5 until the liner 30 is filled up to a desired level within the blast hole 5.

[0096] In another embodiment, a blast hole depth measuring apparatus, such as a dip tape comprising a flexible, elongated line with a weight attached to an end thereof, is inserted into the opening at the top end 21 of the inner tube member 20. The weight at the end of the dip tape engages the sealed end 34

of the liner 30 and draws the liner 30 from the bottom end 23 of the inner tube member 20 until the sealed end 34 of the liner 30 reaches the bottom 8 of the blast hole 5. The dip tape is then withdrawn from the blast hole 5 and, subsequently, the explosives loading hose 50 is fed into the blast hole 5 and used to fill the tubular liner 30 with explosive material 55 in the manner described above.

[0097] The explosive loading hose 50 or the dip tape can measure the depth of the blast hole 5. Depth information can be used to verify that the actual depth of the blast hole 5 accords with the intended depth according to the blast design.

[0098] In another embodiment, the apparatus 10 is configured to include the initiator 80 and the length of lead line 84, pre-installed therein. In an embodiment (not shown) the lead line 84 is wound onto a spool that is attached to the tube member 20 at the upper end 21 thereof. The lead line 84 is fed from the spool until the initiator 80, which is attached to the lead line 84, reaches the desired depth. The desired depth of the initiator 80 will typically be above the bottom 8 of the blast hole 5. For example, the desired depth is preferably about one metre from the bottom 8 of the blast hole 5.

[0099] Subsequently, the operator would stem the blast hole 5 by depositing an amount of stemming material 60, such as aggregated or other chosen stemming material, into the blast hole 5. The stemming material 60 may be deposited into the open end of the liner 30 as illustrated in Figures 7 and 8. The stemming material will usually fill the portion of the blast hole 5 left empty above the explosive material 55 to the level of the open end 6 of the blast hole 5. Alternatively, the stemming material 60 may be deposited outside of the liner 30 by either placing the liner 30 to one side within the blast hole 5 after filling with the desired amount of the explosive material 55 or by pushing the open end of the liner 30 down into the blast hole 5 and depositing the stemming material 60 thereon. Finally, the initiators 80 from a series of the blast holes 5 are tied and fired.

[00100] As illustrated in Figure 8, after the blast hole 5 is loaded with bulk explosive material 55 the outwardly extending protrusion 29 is preferably detached from the top end 21 of the inner tube member 20. In an embodiment, the connection between the outwardly extending protrusion 29 and the inner tube member 20 is comprised of a weakened join that allows the outwardly extending protrusion 29 to be torn away from the inner tube member 20. The inner tube member 20 and the outer tube member 30 can remain within the blast hole 5 at the level of the open end 6 or can drop down or be forced a distance down into the blast hole 5. The stemming material 60 may be deposited into the blast hole before or after detaching the protrusion 29 from the inner tube member 20 and before or after dropping or forcing the inner tube member 20 and the outer tube member 40 down into the blast hole 5.

[00101] The parts of the apparatus 10 that remain within the blast hole 5 when detonation occurs are consumed in the blast. These components include the inner tube member 20 and/or the outer tube member 40 and the length of the flexible tubular liner 30. As the outwardly extending protrusion 29 is detached from the top end 21 of the inner tube member 20 it is not consumed in the blast. Alternatively, the outwardly extending protrusion 29 may be left attached to the top end 21 of the inner tube member 20 to also be consumed in the blast.

[00102] Referring to Figure 14, there is shown a deployment device 200 for deploying the apparatus 10 into a blast hole 5 in accordance with an embodiment of the invention. The deployment device 200 comprises a deployment mechanism including a robotic arm 205 mounted to a vehicle 210. The vehicle 210 includes a store 220 of a plurality of the apparatus 10. The robotic arm 205 is configured to retrieve one apparatus 10 at a time from the store 220 and to lower the apparatus 10 into the open end 6 of a blast hole 5.

[00103] In the embodiment of Figure 14, the robotic arm 205 includes a base portion mounted to the vehicle 210, an intermediate portion pivotally coupled to the base and a distal portion that is movable linearly relative to the intermediate portion. A distal end of the robotic arm 205 is adapted to engage the inwardly facing surface 25 of the inner tube member 20. Preferably, the distal end of the

robotic arm 205 includes a segmented sleeve with a variable diameter that fits inside the inner tube member 20 and radially expands to engage the inwardly facing surface 25 of the inner tube member 20. When the robotic arm 205 places the apparatus 10 into the blast hole 5, the segmented sleeve radially retracts to release the apparatus 10.

[00104] The vehicle 210 is preferably autonomous or semi-autonomous and includes an on-board controller for controlling the operation of drive means and steering means of the vehicle 210. The control module includes a positioning module, which in an embodiment includes a GPS positioning module, and is provided with coordinates data for a blast hole 5 which the controller uses to locate the vehicle 210 adjacent to the blast hole 5.

[00105] When the vehicle 210 has manoeuvred to a location adjacent to a blast hole 5, a sensor is adapted for providing blast hole location data to a controller to cause the robotic arm 205 to deploying the apparatus 10 into the open end 6 of a blast hole 5. The sensor preferably includes a camera or a laser range detection device, or a combination thereof, which generates image and/or range data that is processed by the controller to determine the location of the blast hole 5 relative to the vehicle 210 and/or the robotic arm 205. Thus, the controller uses the location data from the GPS positioning module and/or from the sensor to control the operation of the robotic arm 205 to deploy the apparatus 10 into the blast hole 5.

[00106] In another embodiment, not shown in the Figures, the deployment device includes a feeder that is operable to feed one of the apparatus 10 at a time from the store to a vertical deployment means for vertically deploying the apparatus 10 into the open end 6 of a blast hole 5. The deployment means is adapted to be manually or automatically located over or to some extent into the open end 6 of a blast hole 5. In one embodiment, the vertical deployment means includes a vertically oriented passage with a wide opening at the top and side walls tapering towards a narrower bottom outlet. The apparatus 10 is fed into the open end 6 of the blast hole 5 through the vertical passage. In

another embodiment, the vertically oriented passage may instead be on an incline.

[00107] The inner tube member 20 and/or the outer tube member 40 of the apparatus 10 has a substantially cylindrical form coaxial with the blast hole 5 and thereby forms a barrier preventing surrounding loose rock fragments from falling or collapsing into the blast hole 5.

[00108] The control module is adapted to receive or be programmed with the coordinates of the location of blast holes 5 that are determined, preferably automatically, to require the use of the apparatus 10 because they meet certain criteria including comprising a sub-surface void or cavity 8 in the bedrock, preferably of a depth and/or a dimension above a threshold. The control module causes the vehicle 210 to autonomously manoeuvre the deployment device 200 to locations adjacent to such blast holes 5 one at a time and to autonomously deploy the apparatus 10 into the blast hole 5.

[00109] In another embodiment, the mobile apparatus to which the deployment device 200 is mounted is a drilling rig. The drilling rig and the deployment device are operable to insert the apparatus 10 into a blast hole 5 that has been designated as requiring the use of the apparatus 10 because it comprises a sub-surface void or cavity 8 in the bedrock, preferably of a depth and/or a dimension above a threshold. In another embodiment, the mobile apparatus to which the deployment device is mounted is a mobile processing unit.

[00110] Accordingly, embodiments of the apparatus 10 illustrated in the Figures are advantageous in that they may provide an efficient and convenient method for the delivery of bulk explosives such as ANFO and explosive emulsion mixtures of varying compositions into blast holes. Embodiments of the invention are also advantageous by enabling the efficient loading of blast holes drilled into challenging geologies such as uneven terrain and/or geologies comprising sub-surface voids or cavities in the bedrock. Embodiments of the invention are also advantageous by enabling loading of blast holes with a predetermined amount of explosive material and effectively containing the

explosive material in the blast hole column and preventing the explosive material from spreading out from the blast hole column to fill geological voids penetrated by the blast hole.

[00111] Furthermore, embodiments of the invention are advantageous in that they provide an apparatus that provides an effective blast hole liner that can be quickly deployed into a blast hole. Such embodiments obviate the need for labour intensive and time consuming drawing, cutting and insertion of long lengths of flexible blast hole liner material into a blast hole.

[00112] Furthermore, embodiments of the invention are advantageous in that they provide an apparatus that provides an effective blast hole liner into a blast hole that protects the liner from damage or tearing during the insertion process and/or the explosive loading process.

[00113] 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 lining a blast hole, the apparatus including:
a tube member comprising a wall having an inwardly facing surface and an outwardly facing surface, the inwardly facing surface defining a longitudinal passage that is open at longitudinally opposite ends;
a length of a flexible tubular liner gathered relative to the tube member;
wherein the apparatus is locatable within the open end of a blast hole and the flexible liner is adapted to be drawn from the tube member and filled within the blast hole with bulk explosive material provided through the longitudinal passage of the tube member.

2. The apparatus of claim 1, wherein the apparatus is self-retaining within the blast hole at or near the level of a surface surrounding the open end of the blast hole.

3. The apparatus of claim 1, wherein the tube member includes an outwardly extending part for engaging the open end of the blast hole for retaining the apparatus at or near the level of the surrounding surface.

4. The apparatus of claim 1, wherein the outwardly extending part includes a flange extending outwardly from an end of the tube member.

5. The apparatus of claim 1, wherein the outwardly extending part includes an enlargement of the tube member, wherein the enlargement has an external diameter that is greater than the diameter of the open end of the blast hole, whereby the enlargement is wedged into the open end of the blast hole.

6. The apparatus of claim 1, wherein the tube member is formed out of a rigid plastic material or a rigid paper material or a rigid cardboard material.

7. The apparatus of claim 1, wherein the wall of the tube member is cylindrical.

8. The apparatus of claim 1, wherein the tube member is an inner tube member and the flexible tubular liner is gathered on the outwardly facing surface of the inner tube member.

9. The apparatus of claim 8, further including an outer tube member covering the flexible tubular liner gathered on the inner tube member.

10. The apparatus of claim 9, wherein the outer tube member comprises a wall having an inwardly facing surface and an outwardly facing surface, the inwardly facing surface defining a longitudinal passage that is open at longitudinally opposite ends and wherein the inwardly facing surface of the outer tube member has a larger diameter than the outwardly facing surface of the inner tube member to provide clearance for the flexible tubular liner gathered on the outwardly facing surface of the inner tube member.

11. The apparatus of claim 1, wherein the length of the flexible tubular liner is gathered on the inwardly facing surface of the tube member.

12. The apparatus of claim 1, wherein one end of the flexible liner is sealed and an opposite end of the flexible liner is connected to the tube member.

13. The apparatus of claim 11, wherein the flexible liner is connected to an upper end of the tube member located in use at or near the level of a surface surrounding the open end of the blast hole.

14. The apparatus of claim 1, wherein an insert is located within the upper end of the tube member in an interference fit to thereby retain the flexible liner at or near the level of a surface surrounding the open end of the blast hole.

15. A method for loading bulk explosives into a blast hole, the method including:

locating an apparatus in the open end of a blast hole including a tube member having a length of a flexible tubular liner gathered relative to the tube member;

providing bulk explosive material through a longitudinal passage of the tube member to thereby fill the tubular liner with explosive material within the blast hole, wherein the flexible liner is adapted to be drawn from the tube member upon filling the flexible liner with the bulk explosive material.

16. The method of claim 15, wherein locating the apparatus in the open end of a blast hole includes placing an outwardly extending protrusion of the tube member on a surface surrounding the open end of the blast hole thereby retaining the apparatus at or near the level of the surrounding surface.

17. The method of claim 15, including placing an open end of a length of a lay-flat tubular blast hole liner over the tube member and gathering a length of the liner onto the outwardly facing surface of the tube member.

18. The method of claim 15, including connecting the open end of the tubular liner to an upper end of the tube member and sealing closed the other end of the liner.

19. The method of claim 18, including covering the flexible tubular liner gathered on the outwardly facing surface of the tube member with an outer tube member.

20. The method of claim 15, further including placing an initiator in the flexible tubular liner and depositing an amount of stemming material into the blast hole.

21. A deployment device for deploying an apparatus for lining a blast hole including an inner tube member and a length of a flexible tubular liner gathered relative to the inner tube member, the deployment device including:
a deployment mechanism mounted to a vehicle including a store of a plurality of the apparatus;
the deployment mechanism being operable to deploy one of the apparatus at a time from the store into the open end of a blast hole.

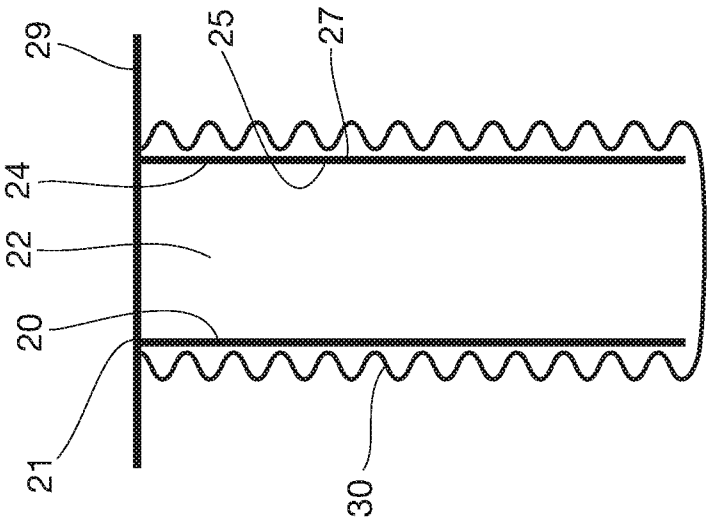

Figure 3

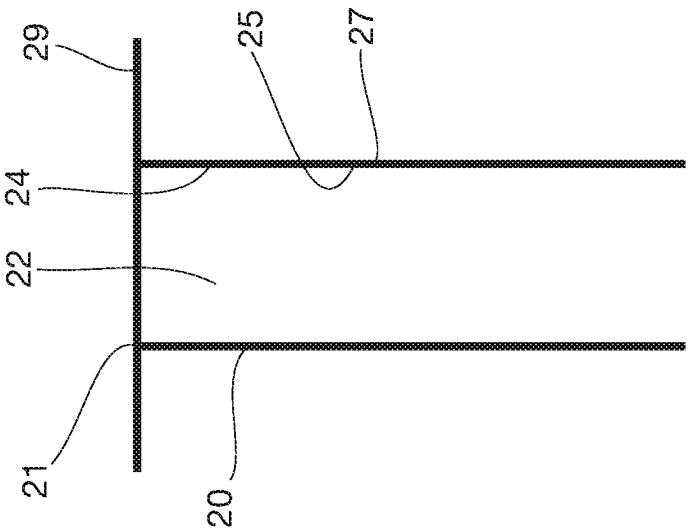

Figure 2

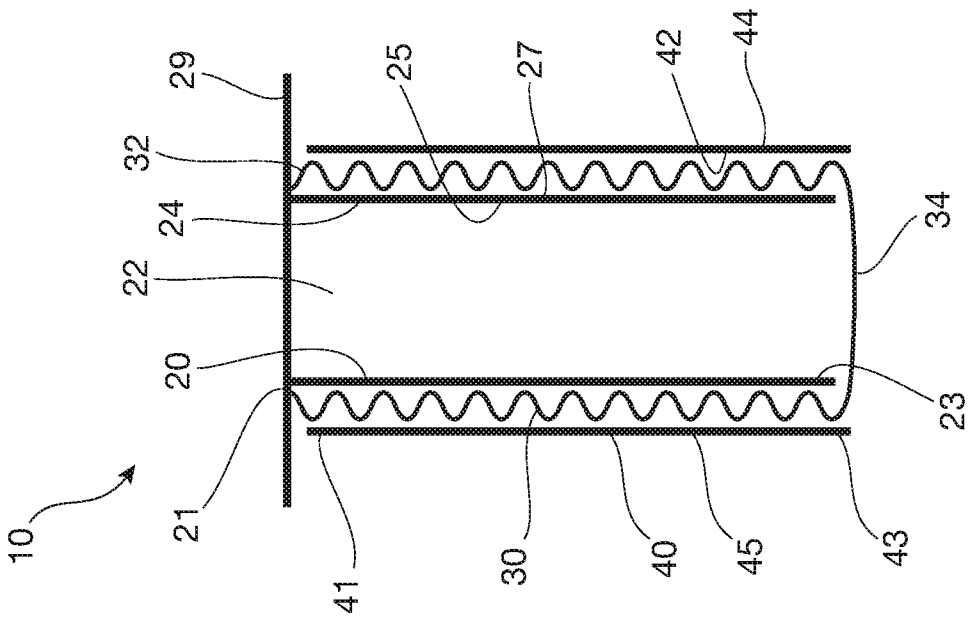

Figure 1

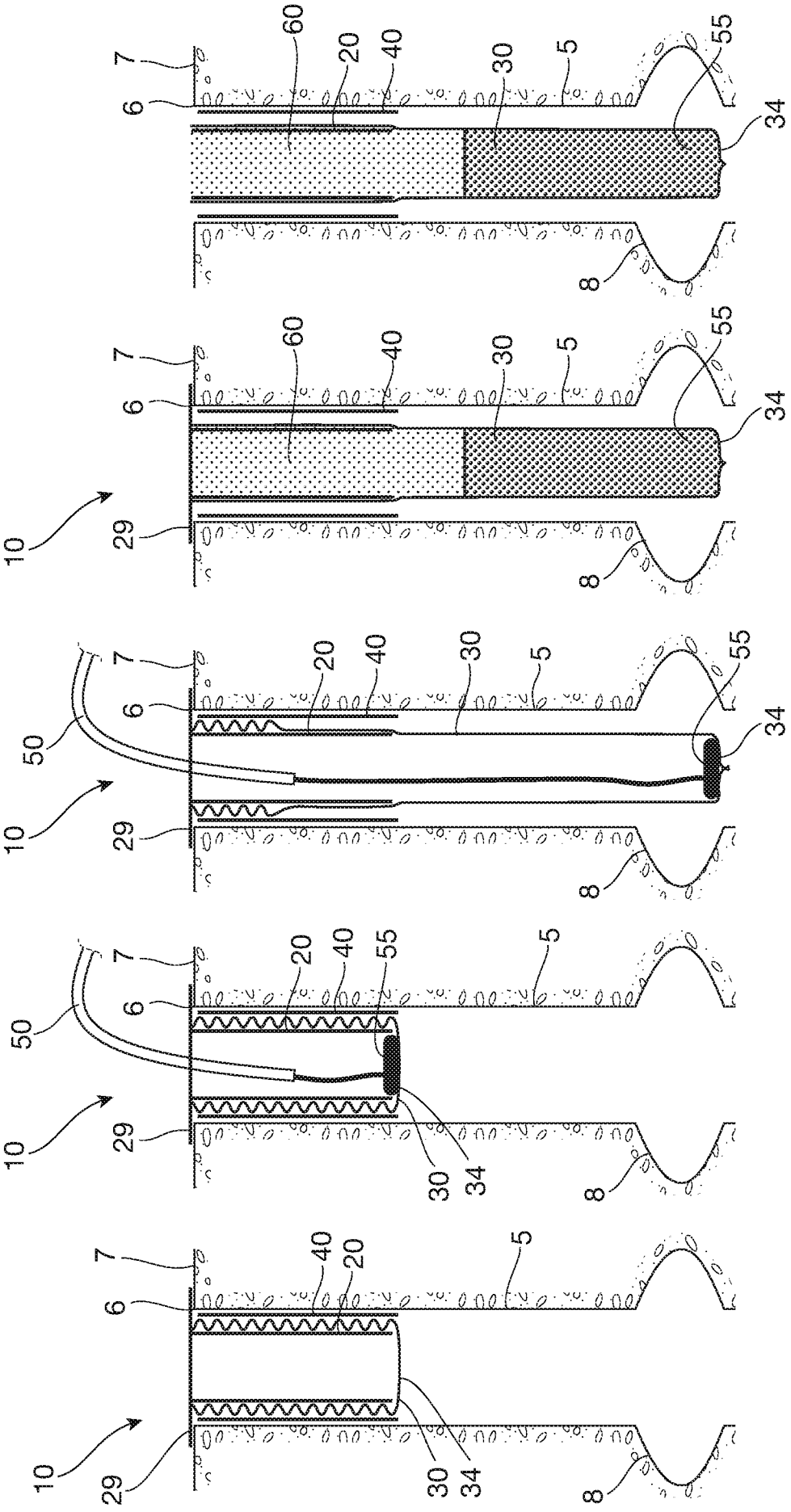

Figure 4

Figure 5

Figure 6

Figure 7

Figure 8

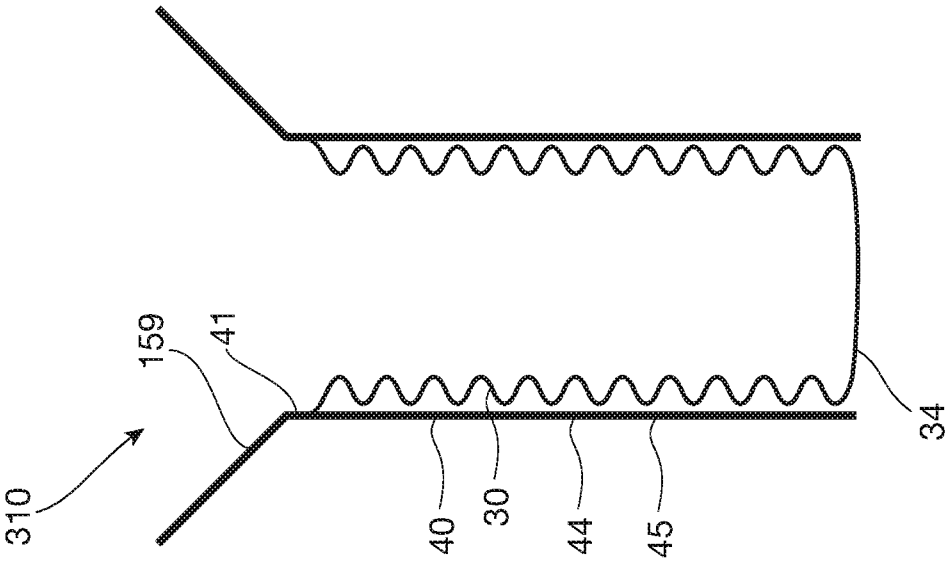

Figure 11

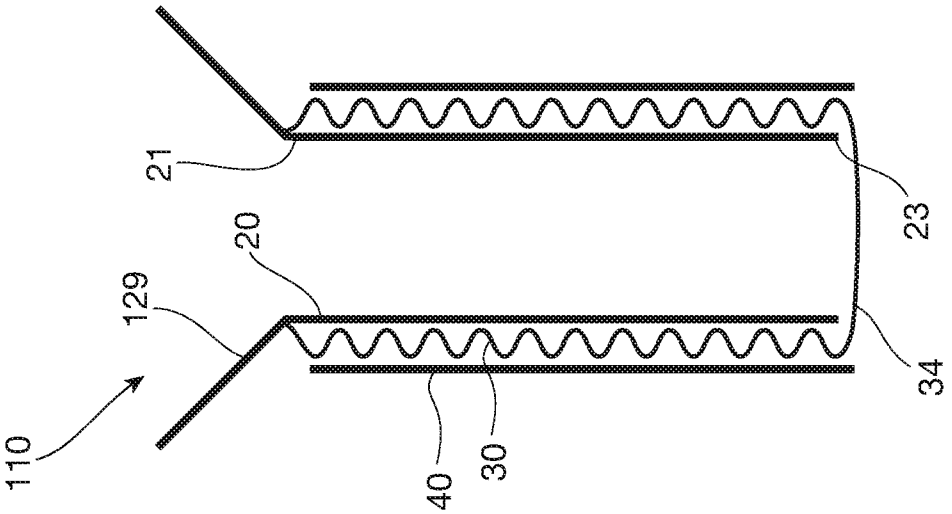

Figure 10

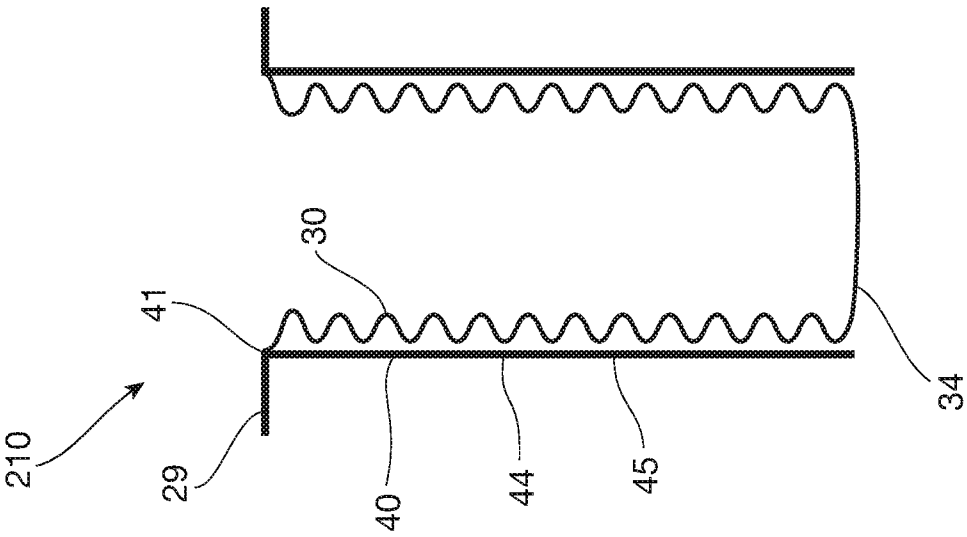

Figure 9

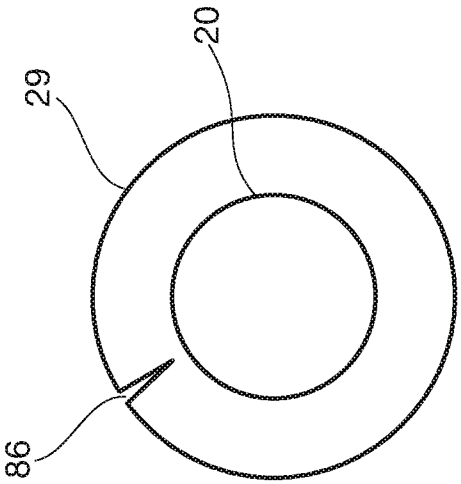

Figure 13

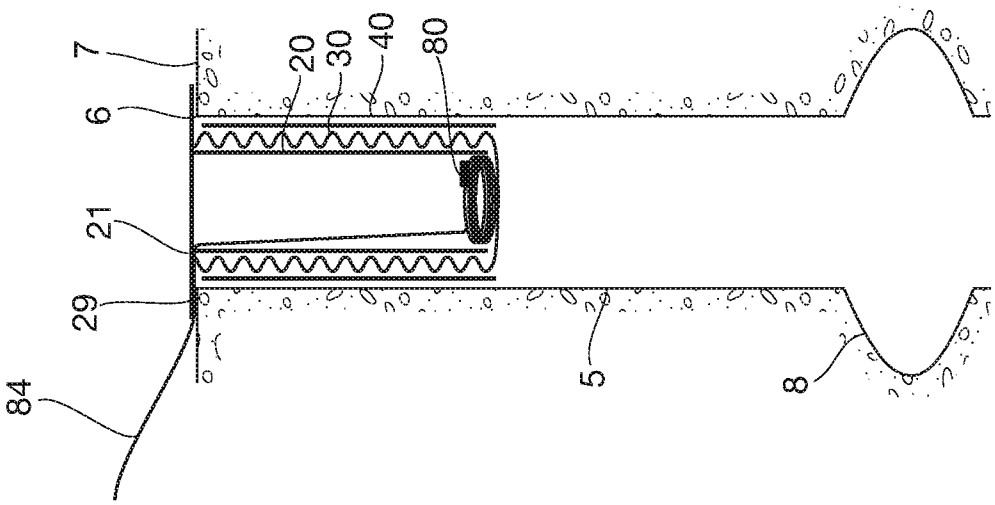

Figure 12

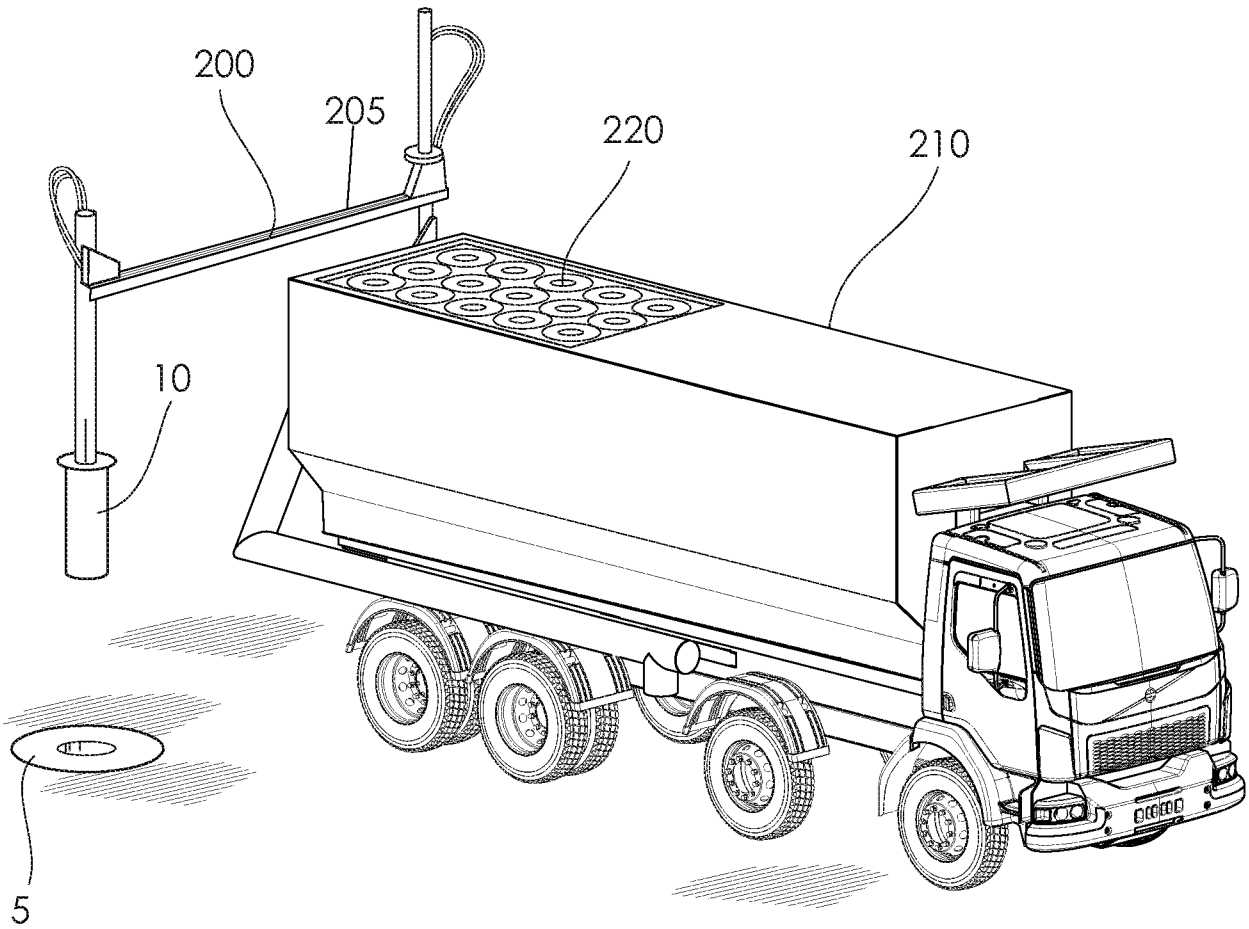

Figure 14

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2023/050181

A. CLASSIFICATION OF SUBJECT MATTER

F42B 3/087 (2006.01) F42D 1/08 (2006.01) F42D 1/22 (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPIAP & EPODOC: IPC & CPC; (F42D1/[02,08,10,20,22], F42B1/[028,32], F42B3/087, F42D3/04): KEYWORDS;(OR SLEEVE, LINER, SOCK, PLEATED, COLLECTED, CONCERTINAED, COLLAR, FUNNEL, MOUNT, DEVICE, HOLDER, ONTO, OVER, ON) and like terms in various combinations. GOOGLE INTERNET; KEYWORDS (AQUIRIAN TECHNOLOGY, GREGORY PATCHING, JONATHAN WRIGHT, DOWNHOLE, BLASTING, BLASTHOLE, LINER, SLEEVE, FUNNEL, ADAPTER, HOLDER, CARTRIDGE, CHARGING, LOADING, DISPENSING) and like terms in various combinations and AUSPAT & EspaceNet Applicant and Inventor Names.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	Documents are listed in the continuation of Box C	

[X] Further documents are listed in the continuation of Box C

[X] See patent family annex

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"D" document cited by the applicant in the international application

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
12 May 2023	12 May 2023

Name and mailing address of the ISA/AU

AUSTRALIAN PATENT OFFICE
PO BOX 200, WODEN ACT 2606, AUSTRALIA
Email address: pct@ipaustralia.gov.au

Authorised officer

Stefan Ochsenbein
AUSTRALIAN PATENT OFFICE
(ISO 9001 Quality Certified Service)
Telephone No. +61 2 6283 2269

INTERNATIONAL SEARCH REPORT C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		International application No. **PCT/AU2023/050181**
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3696703 A (ICI AUSTRALIA LTD et al.) 10 October 1972 Figures 1 & 17 Items 1-10, ABSTRACT, Column 3 Lines 1-6, Column10 Line 25 & Column3 Lines 34-56	1-21
A	AU 2036999 A (COST EFFECTIVE BLASTING PTY LTD) 30 September 1999 Whole Document	1-21
A	RU 199878 U1 (Общество с ограниченной ответственностью "СТАДИЯ") 24 September 2020 Whole Document	1-21
A	RU 182030 U1 (Шумеева Галина Викторовна) 01 August 2018 Whole Document	1-21
A	RU 96945 U1 (APPLICANT UNKNOWN) 20 August 2010 Whole Document	1-21
A	RU 208181 U1 (Долбышев Александр Николаевич) 07 December 2021 Whole Document	1-21
A	US 5198613 A (STEMLOCK INC) 30 March 1993 Whole Document	1-21
A	JP S51114473 U (APPLICANT UNKNOWN) 17 September 1976 Whole Document	1-21
A	US 2018/0106584 A1 (VALE SA) 19 April 2018 Whole Document	1-21
A	WO 2018/223184 A1 (TBS MINING SOLUTIONS PTY LTD)) 13 December 2018 Whole Document	1-21

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2023/050181

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
the subject matter listed in Rule 39 on which, under Article 17(2)(a)(i), an international search is not required to be carried out, including

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

See Supplemental Box for Details

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☒ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

Supplemental Box

Continuation of: **Box III**

This International Application does not comply with the requirements of unity of invention because it does not relate to one invention or to a group of inventions so linked as to form a single general inventive concept.

This Authority has found that there are different inventions based on the following features that separate the claims into distinct groups:

- Claims 1-14 are directed to an apparatus for (suitable) lining a blast hole, the apparatus including: a wall having an inwardly facing surface and wherein the tube member is formed out of a rigid plastic material or a rigid paper material or a rigid cardboard material. The feature of an apparatus for (suitable) lining a blast hole, the apparatus including: a wall having an inwardly facing surface and wherein the tube member is formed out of a rigid plastic material or a rigid paper material or a rigid cardboard material is specific to this group of claims.

- Claims 15-20 are directed to a method for (suitable) loading bulk explosives into a blast hole, the method including placing an open end of a length of a lay-flat tubular blast hole liner over the tube member and gathering a length of the liner onto the outwardly facing surface of the tube member. The feature of a method for (suitable) loading bulk explosives into a blast hole, the method including placing an open end of a length of a lay-flat tubular blast hole liner over the tube member and gathering a length of the liner onto the outwardly facing surface of the tube member is specific to this group of claims.

- Claims 21 are directed to a deployment device for (suitable) deploying an apparatus for lining a blast hole the deployment device including: a deployment mechanism mounted to a vehicle including a store of a plurality of the apparatus; the deployment mechanism being operable to deploy one of the apparatus at a time from the store into the open end of a blast hole. The feature of a deployment device for (suitable) deploying an apparatus for lining a blast hole the deployment device including: a deployment mechanism mounted to a vehicle including a store of a plurality of the apparatus; the deployment mechanism being operable to deploy one of the apparatus at a time from the store into the open end of a blast hole is specific to this group of claims.

PCT Rule 13.2, first sentence, states that unity of invention is only fulfilled when there is a technical relationship among the claimed inventions involving one or more of the same or corresponding special technical features. PCT Rule 13.2, second sentence, defines a special technical feature as a feature which makes a contribution over the prior art.

When there is no special technical feature common to all the claimed inventions there is no unity of invention.

In the above groups of claims, the identified features may have the potential to make a contribution over the prior art but are not common to all the claimed inventions and therefore cannot provide the required technical relationship. The only feature common to all of the claimed inventions and which provides a technical relationship among them is an **apparatus or method of use *for (suitable) lining a blast hole***, the apparatus including an **apparatus** in the open end of a **blast hole** including a **tube member** having a **length** of a **flexible tubular liner gathered** relative to the tube member.

However this feature does not make a contribution over the prior art because it is disclosed in:

US 3696703 A (ICI AUSTRALIA LTD et al.) 10 Oct 1972

Therefore in the light of this document this common feature cannot be a special technical feature. Therefore there is no special technical feature common to all the claimed inventions and the requirements for unity of invention are consequently not satisfied *a posteriori*.

INTERNATIONAL SEARCH REPORT Information on patent family members	International application No. **PCT/AU2023/050181**

This Annex lists known patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document/s Cited in Search Report		Patent Family Member/s	
Publication Number	**Publication Date**	**Publication Number**	**Publication Date**
US 3696703 A	10 October 1972	US 3696703 A	10 Oct 1972
		GB 1300609 A	20 Dec 1972
		ZA 705485 B	28 Apr 1971
		ZM 9870 A1	21 Apr 1972
AU 2036999 A	30 September 1999	None	
RU 199878 U1	24 September 2020	None	
RU 182030 U1	01 August 2018		
RU 96945 U1	20 August 2010		
RU 208181 U1	07 December 2021		
US 5198613 A	30 March 1993	US 5198613 A	30 Mar 1993
		AU 1070592 A	06 Aug 1992
		CA 2060610 A1	05 Aug 1992
JP S51114473 U	17 September 1976		
US 2018/0106584 A1	19 April 2018	US 2018106584 A1	19 Apr 2018
		US 11473892 B2	18 Oct 2022
		AU 2017228716 A1	10 May 2018
		AU 2017228716 B2	29 Sep 2022
		BR 102016024215 A2	02 May 2018
		BR 102016024215 B1	08 Oct 2019
		CA 2982284 A1	17 Apr 2018
		CL 2017002642 A1	24 Aug 2018
		CN 107957224 A	24 Apr 2018
		CN 107957224 B	02 Oct 2020
		MX 2017011901 A	26 Sep 2018
		PE 20180919 A1	05 Jun 2018
		RU 2017134321 A	03 Apr 2019
		SE 1751251 A1	18 Apr 2018
WO 2018/223184 A1	13 December 2018	WO 2018223184 A1	13 Dec 2018

End of Annex

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.