Abstract: A method for installing a roof bolt in a mine, which method comprises: (i) drilling a hole in the roof of a mine; (ii) inserting a resin cartridge having a skin into the hole; (iii) inserting a bolt into the hole and which comprises employing in the hole a tool having one or more sharp elements and wherein the insertion of the bolt causes the tool to puncture the cartridge and prevent the skin from expanding against the wall of the hole.
Declarations under Rule 4.17:
— as to applicant’s entitlement to apply for and be granted a patent (Rule 4.17(ii)) for the following designations: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, EC, EE, ES, FI, GB, GD, GE, GH, GI, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LI, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SI, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG)
— as to the applicant’s entitlement to claim the priority of the earlier application (Rule 4.17(iii)) for the following designations: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, EC, EE, ES, FI, GB, GD, GE, GH, GI, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LI, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SI, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG)
— of inventorship (Rule 4.17(iv)) for US only

Published:
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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.
EQUIPMENT FOR USE IN MINES AND METHOD OF USE

Field of the Invention

This invention relates to equipment for use in mines, more particularly to roof bolts and a method for using same.

Background of the Invention

Roof bolts are well known in the mining industry and are extensively employed for consolidating the roof and providing anchoring points and support. Their use involves drilling a hole in the roof of the mine and inserting into the hole a resin filled cartridge. The resin filled cartridges are also well known and comprise a curable resin and a catalyst for the resin contained within a sausage-like skin. In the next step of the installation a bolt is inserted which pierces the skin and penetrates the resin. The bolt is usually spun to mix the resin and catalyst and, once mixed, the resin cures and sets.

Problem to be solved by the Invention

There is a long standing problem in coal mining, particularly when employing small diameter bolts, of a phenomenon called glove fingering. The problem arises when the bolt is inserted into the hole pressurising the cartridge and forcing the skin to the hole wall and then boring a hole through the contents of the cartridge leaving the skin intact. The result is that there is little direct contact of the wall by the resin and hence a less than optimum anchorage.

Previous attempts to solve the problem have involved the use of a thinner skin to contain the resin, coarse filler in the cartridge and slash cut bolts. However these have not generally been successful.

There have also been proposals to improve the mixing of the contents of the
cartridge.

For example it has been proposed to:

(i) provide metal coils spiralling around and attached to the roof bolt
(ii) provide enlarged cylindrical sections of the roof bolt, for example a tubular sleeve around the bolt itself to decrease the annulus between the bolt and the bore hole in an effort to improve shear mixing when the bolt is spun,
(iii) retaining washers and/or clips around the leading portion of the anchor bolt which retains the resin in the upper portion of the bore hole to assist anchorage of the expansion shell and
(iv) a washer or ferrule crimped on the end of a cable bolt to improve the shear mixing upon insertion.

These earlier proposals are described in United States Patents Nos 4,194,858; 4,516,886; 4,664,561; 4,655,645; 4,704,053; 5,042,961; 5,052,861; 5,076,734; 5,259,703 and 5,378,087.

However none of these earlier proposals addresses the problem of glove fingering mentioned above.

The present invention provides a solution to this problem by the use of a device to puncture the skin of the cartridge and thereby improve the contact between the resin and the wall of the bore hole.

Summary of the Invention

According to the present invention there is provided a method for installing a roof bolt in a mine which method comprises:

(i) drilling a hole in the roof of a mine
(ii) inserting a resin cartridge having a skin into the hole
(iii) inserting a bolt into the hole and which comprises employing in the hole a tool having one or more sharp elements and wherein the insertion of the bolt causes the tool to puncture the cartridge and prevent the skin from expanding against the wall of the hole.

According to another aspect of the present invention there is provided an assembly comprising:

a cartridge and attached to one end thereof a tool having a sharp element which on the application of pressure in the bore hole is capable of puncturing the skin
of the cartridge and depressurising the cartridge.

**Advantageous Effect of the Invention**

The use of the invention improves the contact of the resin with the wall of the bore hole and thereby provides an improved anchor.

**Brief Description of the Drawings**

- Fig 1a is a side view of the tool
- Fig 1b is a bottom view of the tool
- Figs 2a, 2b and 2c show the attachment of the tool to the resin cartridge and the insertion of the assembly into a bore hole
- Figs 3a, 3b, 3c and 3d show the operation of the tool and the puncturing of the resin cartridge.

**Detailed Description of the Invention**

The term mine in the present specification is intended to include quarries, tunnels and all underground earthworks.

The term roof is intended to include not only an overhead surface but also walls and all surfaces into which anchor bolts are inserted.

According to a further aspect of the present invention there is provided a tool for use with a cartridge to puncture the cartridge said tool comprising a base of suitable size and cross section to be inserted in a bore hole and, extending from the base one or more sharp elements disposed so that when the tool is located in a bore hole with the base towards the bottom of the hole, the elements project towards the mouth of the hole.

Referring to Figs 1a and 1b, the tool of total height H comprises a top cylindrical portion 1 of outer diameter D equal to the cartridge diameter and thickness t equal to 0.5H, with a 45° chamfer of the upper face 2 to a depth of 0.25t, and a lower face 3 containing eight teeth 4 equally spaced at 45 degrees about the perimeter of 3. A hole 5 of diameter d1=D/2 extends entirely and concentrically through the cylindrical portion 1 and circular channels or flutes 6 each of radius r1=d2/2 run longitudinally along the outer surface of portion 1 at a depth d and equally spaced between the teeth 4. Four rectangular through slots 7 of arc width w and height h are located in portion 1 at a distance of 0.75t from lower face 3, equally spaced 90 degrees around D. The teeth are each of length L equal to 0.5H and their maximum diameter is at position 8 with a magnitude represented by d2 tapering to a reduced diameter 9 of d3= 0.75d2 at face 3.
Each tooth tapers to a point at the free end 10 from which a flexible finger 11 of length 1 equal to 0.52D and diameter d4 equal to t/16 extends radially towards the disk centre at an angle of 15 degrees from horizontal towards lower face 3. Circular channels or flutes 12 of radius r2=d2/2 run longitudinally through the inner surfaces of teeth 4 with their axes parallel to the central axis of cylindrical portion 1 and set in the teeth at a depth of r2 at 8.

The tool is injection moulded of a hard, durable plastics material such as rhinite or nylon using a multiple stage mould though other materials may be used.

Referring to Figs 2a, 2b and 2c: in use the tool is pressed onto the clip 13 of the cartridge 14 bending the fingers 11 of the tool until they clear and wedge against the underside 15 of the clip 13 thereby retaining the tool on the clip (Fig 2b) and allowing the cartridge to be inserted into the borehole 16 in the preferred orientation with the tool end leading (Fig 2c).

During the normal bolting cycle the roof bolt 17 is inserted into the bore hole 16 advancing the cartridge 14 towards the top 18 of the bore hole (Fig 3a). As the bolt insertion continues, the tool element contacts the end of the hole (Fig 3b) whereupon compression of the cartridge between the bolt tip 19 and the teeth 4 of the tool is begun sufficiently to puncture the ball end 20 of the cartridge (Fig 3c). Continued insertion of the bolt serves to implement the flat bolt tip 19 as a plunger to extrude the resin contents 21 of the cartridge from the punctured end 20 thus affording annular flow of the resin contents between the cartridge skin 22 and bore hole wall 23 as illustrated in Fig 3d.
Claims:

1. A method for installing a roof bolt in a mine which method comprises (i) drilling a hole in the roof of a mine (ii) inserting a resin cartridge having a skin into the hole (iii) inserting a bolt into the hole and which comprises employing in the hole a tool having one or more sharp elements and wherein the insertion of the bolt causes the tool to puncture the cartridge and prevent the skin from expanding against the wall of the hole.

2. A method as claimed in claim 1 which comprises inserting the tool into the bore hole prior to the cartridge.

3. A method as claimed in claim 1 which comprises attaching the tool to the leading end of the cartridge prior to insertion in the hole so that the sharp elements point towards the cartridge.

4. A method as claimed in claim 1 which comprises attaching the tool to the tip of the bolt so that the sharp elements point towards the cartridge.

5. An assembly for use in roof bolting said assembly comprising: a cartridge and attached to one end thereof a tool having a sharp element which on the application of pressure in the bore hole is capable of puncturing the skin of the cartridge and depressurising the cartridge.

6. An assembly as claimed in claim 5 wherein the tool is attached to the clip of the cartridge.

7. An assembly as claimed in claim 5 or 6 wherein the sharp element comprises a plurality of teeth arranged so that when the assembly is inserted into a bore hole the
teeth project towards the cartridge.

8. A tool for use with a cartridge to puncture the cartridge said tool comprising: a base of suitable size and cross section to be inserted in a bore hole and, extending from the base one or more sharp elements disposed so that when the tool is located in a bore hole with the base towards the bottom of the hole, the element projects towards the mouth of the hole.
### INTERNATIONAL SEARCH REPORT

**A. CLASSIFICATION OF SUBJECT MATTER**  
IPC 7 E21D20/02 E21D21/00

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)  
IPC 7 E21D

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 practical, search terms used)  
EPO-Internal, PAJ, WPI Data

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

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**X** Further documents are listed in the continuation of box C.  
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**Z** document member of the same patent family

**Date of the actual completion of the international search**  
23 October 2001

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