

⑫ **EUROPEAN PATENT SPECIFICATION**

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⑳ **Yield tube rib bolt assembly.**

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US-A-4 058 079</p> | <p>㉖ Proprietor: Jim Walter Resources, Inc.
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Description

This invention relates to a yield tube rib bolt assembly being useful in the underground mining of minerals and particularly the mining of coal. While this invention is especially applicable in coal mining operations, and will be described in that environment, the scope of the invention should not be limited to that type of operation.

Generally, in a coal mining operation, coal is removed from the face of a coal seam and deposited onto a flexible conveyor for removal from the mine.

Throughout the mine there are passageways which permit miners to move around through the mine. These passageways are separated by pillars which are areas of the mine that have not been mined. As these pillars have exposed faces, the vertical forces on the pillars cause the pillars to expand into the passageways. If the expansion is severe, the pillar side may collapse into the passageways.

In order to keep the pillar side from collapsing, angled rib bolts are used to support the exposed sides of the pillars in the mine. These bolts are inserted into long holes drilled into the face of the pillar, usually at a 45° angle with respect to the face of the pillar. The bolts are held in place by an expansion shell or set resin in which one end of the bolt is anchored.

In the past, a crescent washer at the head or exposed end of the bolt held a header or bearing plate against the face of the pillar to inhibit expansion of the pillar side and prevent its collapse. One of the problems which occurred in the prior art structure was the breakage of the rib bolt when the stress of the expanding pillar exceeded the failure strength of the rib bolt.

In order to overcome that problem, it has been proposed to place a yield device between the exposed end of the bolt and the header or bearing plate. The yield device permits the pillar to expand outwardly and keeps a constant tension on the bolt. However, because the yield device gradually collapses or splits in a controlled manner, the rib bolts do not abruptly break. Once the yield device is destroyed, the bolt head acts against the bearing plate and the bolt then acts as standard rib bolt undergoing load elongation.

The yield device should also allow the pillar to temporarily distress itself while maintaining rib bolt control. This should further increase rib longevity and especially prevent rib bolt failures in coal face work areas.

From the FR—A—1 236 570(2) it is known to form the bearing plate as a yield device. For that reason the bearing plates are provided with anti-clinal bulges having complicated shapes which serve as crushable bins.

In the case of setting the anchor bolt in an acute angle with respect to the wall face, the bearing plates have additionally to be adapted to that angle.

However, with that construction the possible

adjusting path is confined to the size of the anti-clinal bulges.

In the DE—U—8 317 269 an anchor for securing loaded mountains is described which comprises a yield device consisting of a wear cylindrical shell being disposed between the anchor head and the bearing plate and encompassing the anchor rod. The anchor head has the shape of a spherical segment or a truncated cone projecting into the cylindrical shell and possesses a lead-in boring for the anchor shaft. If the pillar expands outwardly, the anchor head moves into the cylindrical shell while expanding the shell.

However a disadvantage of this construction is that the anchor head and the cylindrical shell have to be precisely manufactured to fit each other in order to offer an exactly definable counter-holding force. Moreover, even small amounts of dust, or sand adhering to the surface of the anchor head or the inner surface of the cylindrical shell strongly influence the magnitude of the counter-holding force.

Furthermore, as the anchor head disappears in the cylindrical shell, the expansion of the pillar is difficult to control.

The present invention as claimed in claim 1 relates to a simple yield device which inhibits rib bolt breakage and controls horizontal expansion of pillars in coal mines without having the above-described disadvantages. It is an object of the invention to provide a novel device for controlling the expansion of pillars in coal mines and reduce rib bolt failures. It is another object of the invention to provide a novel device for controlling the expansion of pillars and coal mines in a simple, yet effective manner. Other objects and advantages of the present invention will become apparent to those skilled in the art from a consideration of the attached drawing in which like numerals indicate like elements and in which:

Figure 1 is a cross-sectional elevational view of a portion of a coal mine with the novel device of the invention installed.

Figure 2 is an expanded view of a portion of Figure 1 showing the novel device of the invention in greater detail, and

Figure 3 is a perspective view, partially in cross-section, of the novel device of the invention.

Referring now to Figures 1 and 2, there is therein shown a cross-section of a coal mine with a passageway 10 running under a roof 12 which may be a strata of coal or overburden. Along one side of passageway 10 is a seam face 14 which is the edge of a strata of coal or rock which forms pillar 16. Passageway 10 has a floor 18. Passageway 10 is made by mining out the minerals in the seam.

In order to prevent outward collapse of pillar 16, an angled rib bolt 20 is used to secure a bearing plate against face 14 of pillar 16.

Rib bolt 20 may be a conventional bolt used in mining operations as a roof bolt and consists of a shank 22 which is threaded at end 24 for

engagement with a bolt expansion shell anchor unit 25. Expansion shell anchor unit 25 may be of the type sold commercially by the Birmingham Bolt Company of Ensley, Alabama. Rib bolt 20 may be an elongated $\frac{3}{4}$ inch (1.91 cm) diameter rod of grade 55 steel which will break or fail when a stress of about 30,000 pounds (13,620 kg) is applied to it. Of course, other rib bolts of different diameter and material may be used, each having a maximum load bearing capacity before failure. The maximum load before failure may range from 20,000 pounds (9,080 kg) to 30,000 pounds (13,620 kgs) or more depending upon the diameter and material of the rib bolt.

The shank 22 of the present rib bolt may be made of steel, fiberglass, wood, and the bolt head of steel, fiberglass, or cast iron.

Bolt head 26 includes a main body portion which is of nutlike configuration, one end of which is enlarged to provide a peripheral flange 28 which is uniplanar with a body terminal.

A washer 30 may be placed over shank 22 of rib bolt 20 and rests against peripheral flange 28 of bolt head 26.

A collapsible yield device 32 is placed over shank 22 of rib bolt 20 and rests against washer 30 or flange 28. Collapsible yield device 32 may be a hollow steel tube of 14 to 16 gauge. End 34 of tube 32 rests against washer 30 or flange 28. End 34 of yield device or tube 32 is cut at right angles to the longitudinal axis of tube 32 so that its end 34 fits snugly against washer 30 or flange 28. The other end 36 of tube 30 is cut at an angle of about 45° (equal to the acute angle which rib bolt 20 makes with face 14 of pillar 16).

A bearing plate 38, having a central hole, is placed over shank 22 of rib bolt 20 to rest against end 36 of tube 32. Bearing plate 38 may be of variable thickness and dimension (6 inches (15.24 cm) in width by 16 inches (40.64 cm) in length is common). Angle rib bolt 20 is inserted in a hole 40 (see Figure 2) drilled in a conventional way into pillar 16 at an angle of about 45° with respect to the vertical face 14 of pillar 16. To hold the upper end of rib bolt 20 securely in place, an expansion shell anchor or set resin is used at the upper end of hole 40. After hole 40 has been drilled in pillar 16, rib bolt 20 with an expansion shell anchor is then pushed up until the bearing plate 38 is in position against the pillar face 14. Rib bolt 20 is then rotated. During the rotation of rib bolt 20, the expansion anchor sets, rib bolt 20 is tightened upwardly in hole 40 until bearing plate 38 fits snugly against face 14. After the bolt is tightened, rib bolt 20 holds bearing plate 38 tightly against face 14 while yield device or tube 32 is held tightly against bearing plate 38 by the compression effect of washer 30 and bolt head 26.

The rotation of rib bolt 20 is accomplished by a mechanically driven socket which applies a torque which generates a minimum bolt load of about 2,500 pounds. Figure 3 shows collapsible yield device 32 in greater detail. Collapsible yield device 32 is a hollow, round tube of steel or other high tensile strength material with an outside

diameter of approximately $1\frac{5}{8}$ " and of variable length (6 inches may be used).

The outside diameter need only be less than the diameter of washer 30 or bolt flange 28 which may be 2-inches in diameter. Washer 30 or bolt flange 28 is of hardened steel, so that tube 32 can collapse or split between its ends 34 and 36 when sufficient stress is placed on tube 32 as it is being compressed between washer 30 and bearing plate 38. The inner diameter of tube 32 need only be large enough to accommodate the shank 22 of rib bolt 20 which may be $\frac{3}{4}$ inch (1.91 cm) in outer diameter. Tube 32 may be of 14 to 16 gauge in thickness. The strength of tube 32 is determined by its thickness and the nature of the material of which it is made. The strength of tube 32 should be such that tube 32 will not collapse when the setting torque is applied to bolt head 26, but tube 32 will collapse at a load below the failure strength of the rib bolt. For example, for a rib bolt of $\frac{3}{4}$ inch (1.91 cm) in diameter of grade 55 steel, tube 32 should not collapse at a load of 2,500 pounds (1,135 kg), but will collapse or split at a load below 30,000 pounds (13,620 kg).

After the assembly of the rib bolt 20, the bolt head 26, the washer 30, the yield device 32 and bearing plate 38 has been secured in place, the system will provide support for pillar 16. Of course a system of such rib bolt assemblies will be used in an actual mine setting. Generally, such rib bolt assemblies are installed on approximately 4-ft. (1.22 m) centers.

In an actual installation in which rib bolt assemblies with and without yield devices were compared, it was found that as the pillar expanded, the yield tubes began to split or crush prior to the breaking of all the rib bolts which did not have yield tubes. As the pillar further expanded beyond the point where all of the rib bolts without yield tubes were broken, 50 percent of the yield tubes deformed to where the washer rested against the bearing plate. At this point, no rib bolts of those assemblies with yield tubes failed. Even as the pillar further expanded up to the point where 80 percent of the yield tubes were deformed so that the washer was resting against the bearing plate, none of the rib bolts of this assembly broke.

While the present invention has been illustrated and described in connection with a conventional expansion shell anchor type bolt assembly, it is to be understood that it may also be employed with a resin type rib bolt or roof bolt by making appropriate changes to the various elements of the invention.

Various other changes may be made within the scope of the appended claims.

Claims

1. A combination comprising an elongated rib bolt (20) to be fixed in a mine at one end in a receiving hole (40) in a mine wall (14), the rib bolt having an exposed portion extending outwardly beyond the face of the mine wall and terminating

in an exposed end, the rib bolt further having a predetermined failure strength, a bearing plate (38) mounted on the rib bolt portion and resting against the mine wall, a cylindrical shell (32) encompassing the rib bolt mounted on the exposed portion between the bearing plate and the exposed end, the cylindrical shell permitting the wall face to expand outwardly by being gradually destroyed, and means (26, 28, 30) mounted on the exposed end for tightly compressing the cylindrical shell and the bearing plate together and forcing the bearing plate tightly against the face of the mine with a predetermined torque, the cylindrical shell being capable of withstanding the predetermined torque characterized in that the cylindrical shell (32) is longitudinally collapsible with a predetermined adjustable collapsing-rate in response to an applied force lower than the predetermined failure strength of the rib bolt (20), thus keeping a constant tension on the rib bolt (20).

2. The combination as recited in claim 1, characterized in that the cylindrical shell (32) is made of metal.

3. The combination as recited in claim 1 in which the predetermined torque generates a minimum load of about 2,500 pounds (1,135 kg) and the failure strength of the rib bolt is about 30,000 pounds (13,620 kg).

4. The combination as recited in claim 1 in which the cylindrical shell (32) will not collapse under a longitudinal compressive load of about 2,500 pounds (1,135 kg) but will collapse under a compressive load of less than about 30,000 pounds (13,620 kg).

5. The combination as recited in claim 1 in which the rib bolt (20) is fixed in a receiving hole (40) in the face of a mine, which receiving hole (40) is directed at an acute angle with respect to the face (14) of the mine and the cylindrical shell (32) has one end (34) perpendicular to its longitudinal axis and has a distant end (36) lying in a plane at an acute angle with respect to its longitudinal axis, the acute angle of the receiving hole (40) being equal to the acute angle of the distant end (36) of the cylindrical shell (32).

Patentansprüche

1. Eine Kombination, mit einem verlängerten Gebirgsanker, der in einer Grube an einem Ende in einem Aufnahmeloch in einer Grubenwand befestigt wird, wobei der Gebirgsanker ein exponiertes Teilstück aufweist, das sich nach außen über die Front der Grubenwand erstreckt, und in einem exponierten Ende abschließt, und wobei der Gebirgsanker weiterhin einen festgelegten Bruchwiderstand aufweist, einer Sohlplatte, die auf das Gebirgsankerteilstück montiert ist, und die an der Grubenwand anliegt, einer zylindrischen Hülse, die den Gebirgsanker einschließt, und auf der exponierten Teilstück zwischen der Sohlplatte und dem exponierten Ende montiert ist, wobei die zylindrische Gehäuse der Wandfront gestattet, sich nach außen auszudehnen,

indem sie nach und nach zerstört wird, und auf das exponierte Ende montierte Mittel, um das zylindrische Hülse und die Sohlplatte fest zusammen zu pressen und die Sohlplatte mit einem festgelegten Drehmoment fest gegen die Front der Grubenwand zu drücken, wobei die zylindrische Hülse in der Lage ist, das festgelegte Drehmoment auszuhalten, dadurch gekennzeichnet, daß die zylindrische Hülse (32) in ihrer Längsrichtung mit einer festgelegten, einstellbaren Kollabierrate als Antwort auf eine angelegte Kraft, die geringer als der festgelegte Bruchwiderstand des Gebirgsankers (20) ist kollabierbar ist, um so eine konstante Spannung auf den Gebirgsanker (20) zu erhalten.

2. Kombination nach Anspruch 1, dadurch gekennzeichnet, daß die zylindrische Hülse (32) aus Metall gefertigt ist.

3. Kombination nach Anspruch 1, dadurch gekennzeichnet, daß das festgelegte Drehmoment einen Mindestdruck von ungefähr 2.500 pounds (11,131 N) erzeugt, und daß der Bruchwiderstand des Gebirgsankers ungefähr 30.000 pounds (133,567 N) beträgt.

4. Kombination nach Anspruch 1, dadurch gekennzeichnet, daß die zylindrische Hülse (32) nicht unter einem Pressdruck in Längsrichtung von ungefähr 2.500 pounds (1,135 kg), sondern unter einem Pressdruck von weniger als ungefähr 30.000 pounds (13.620 kg) kollabiert.

5. Kombination nach Anspruch 1, dadurch gekennzeichnet, daß der Gebirgsanker (20) in einem Aufnahmeloch (40) in der Front einer Grubenwand befestigt ist, wobei das Aufnahmeloch (40) in einem spitzen Winkel in Bezug auf die Front der Grubenwand ausgerichtet ist, und daß die zylindrische Hülse (32) ein zu ihrer Längsachse senkrecht Ende (34) und ein beabstandetes Ende (36) aufweist, das in einer Ebene liegt, die einen spitzen Winkel in Bezug auf ihre Längsachse bildet, wobei der spitze Winkel des Aufnahmelochs (40) gleich dem spitzen Winkel des beabstandeten Endes (36) der zylindrischen Hülse (32) ist.

Revendications

1. Ensemble combiné comprenant un boulon d'ancrage allongé (20) destiné à fixé, par une extrémité, dans une mine, dans un trou de réception (40) ménagé dans une paroi (14) de la mine, le boulon d'ancrage comportant une partie dégagée s'étendant à l'extérieur de la face de la paroi de la mine et se terminant par une extrémité dégagée, le boulon d'ancrage possédant en outre une résistance prédéterminée à la rupture, une plaque d'appui (38) montée sur ladite partie du boulon d'ancrage et prenant appui contre la paroi de la mine, une coque cylindrique (32) entourant le boulon d'ancrage et montée sur la partie dégagée entre la plaque d'appui et l'extrémité dégagée, la coque cylindrique permettant une dilatation, en direction de l'extérieur, de la face de la paroi, sous l'effet de sa destruction graduelle, et des moyens (26, 28, 30) montés sur la partie

dégagée de manière à comprimer fortement la coque cylindrique et la plaque d'appui l'une contre l'autre et à repousser fortement la plaque d'appui contre la face de la mine avec un couple prédéterminé, la coque cylindrique étant apte à résister au couple prédéterminé, caractérisé en ce que la coque cylindrique (32) peut être aplatie longitudinalement avec un taux réglable prédéterminé d'aplatissement, en réponse à une force appliquée inférieure à la résistance prédéterminée à la rupture du boulon d'ancrage (20), ce qui maintient l'application d'une tension constante à ce dernier.

2. Ensemble combiné selon la revendication 1, caractérisé en ce que la coque cylindrique (32) est réalisée en un métal.

3. Ensemble combiné selon la revendication 1, dans lequel le couple prédéterminé produit une charge minimale d'environ 2500 livres (1,135 kg) et la résistance à la rupture du boulon d'ancrage est égale à environ 30000 livres (13,620 kg).

4. Ensemble combiné selon la revendication 1, dans lequel la coque cylindrique (32) ne s'aplatit pas sous l'action d'une charge de compression longitudinale d'environ 2500 livres (1,135 kg), mais s'aplatit sous l'action d'une charge de compression inférieure à environ 30 000 livres (13,620 kg).

5. Ensemble combiné selon la revendications 1, dans lequel le boulon d'ancrage (20) est fixé dans un trou de réception (40) ménagé dans la face d'une mine et dirigé de manière à faire un angle aigu par rapport à la face (14) de la mine, et la coque cylindrique (32) possède une extrémité (34) perpendiculaire à son axe longitudinal et une extrémité distante (36) située dans un plan faisant un angle aigu par rapport à l'axe longitudinal de la coque, l'angle aigu du trou de réception (40) étant égal à l'angle aigu de l'extrémité distante (36) de la coque cylindrique (32).

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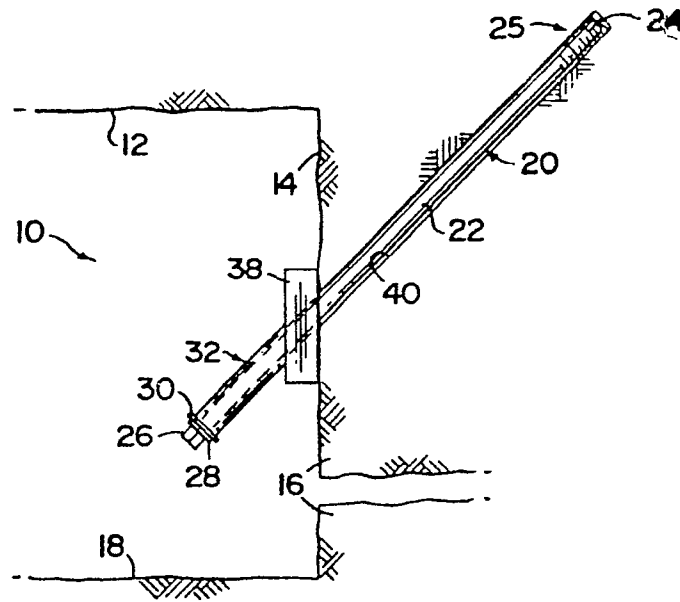


FIG. 1

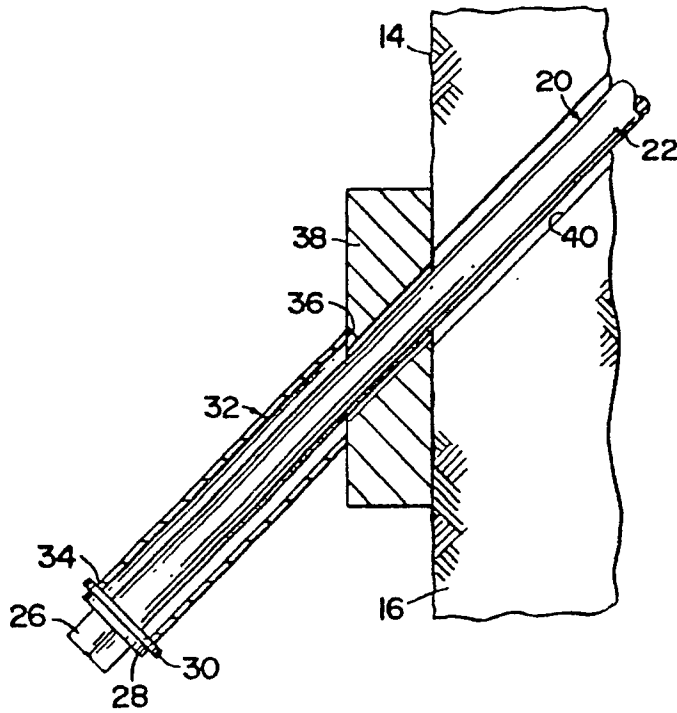


FIG. 2

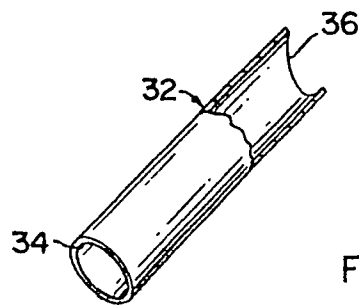


FIG. 3