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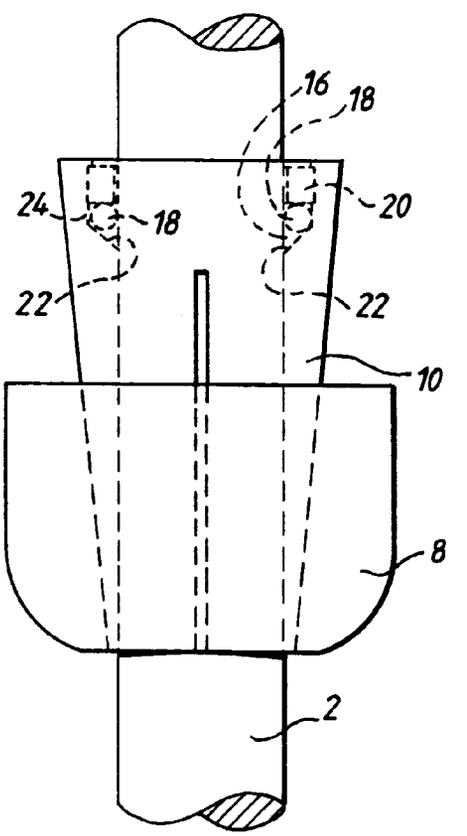
(54) Rockbolt assemblies

(57) A rockbolt assembly comprises a bolt (2) for securement in a substrate (4) with an end length projecting therefrom. A spreader plate (6) fits over the end length and engages the surface of the substrate around the rockbolt. A sleeve (8) is mounted on the rockbolt (2) and engages the spreader plate (6), and a locking tube (10) having a split tapering profile is received in the sleeve (8). The locking tube (10) has a one-way fixing mechanism (16, 18, 20) mounted on its inner surface for engagement with the bolt (2). The mechanism permits movement of the tube (10) along the bolt (2) in the direction in which the split profile tapers, but resists movement in the opposite direction by engagement with the bolt (2).

Fig.2.



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Description

This invention relates to rockbolts and more particularly, to assemblies adapted to enhance the securement of rockbolts in and against a substrate. Such assemblies serve to place the ground or substrate under compressive stress, giving it the greatest stability, and reducing the likelihood of collapse. This is particularly valuable in underground environments such as mines.

A rockbolt is typically secured in a substrate by firstly drilling a hole in the substrate for receiving the bolt. A quantity of resin or cement is then inserted into the hole, after which the bolt is installed. Instalment of the bolt displaces the resin, and the aim is normally to have the hole substantially filled with resin and rod; i.e. to the exclusion of air, when the bolt is fully in place. When the resin or cement cures, the rockbolt is effectively bonded to the substrate. Establishing that the resin or cement has been cured can be accomplished by rotating the rockbolt in the hole until such rotation is effectively prevented.

In order to place under compression the volume of substrate in which the rockbolt is installed, it is normal to fit over the exposed end of a secured rockbolt a spreader plate which engages the substrate around the bolt. A nut is then installed on the threaded rockbolt end, and turned to clamp the spreader plate against the substrate. The clamping force is of course entirely dependent upon the bond established by the resin or cement between the installed length of rockbolt and the surrounding substrate. Once secured in this manner, the exposed end of the rockbolt can be used for the fitment or mounting of other elements.

It is recognised that the ground or substrate in which rockbolts are commonly installed is subject to significant movement, to some extent because of adjacent workings or activity. For whatever reason however, there is a possibility that a rockbolt can become loosened. Some self-locking mechanisms have been proposed, but these have not always been successful, and can be expensive.

The present invention is directed at a simple and expedient means by which a spreader plate can be secured against the substrate by the rockbolt assembly. According to the invention, a rockbolt assembly comprises a bolt for securement in a substrate with an end length projecting therefrom; a spreader plate for fitting over the end length and engaging the surface of the substrate around the rockbolt, and a sleeve for mounting on the rockbolt and engaging the spreader plate. In order to hold the sleeve against the spreader plate, and thereby the spreader plate against the substrate, a locking tube is mounted on the projecting length of rockbolt, which tube has a split tapering profile to be received in the sleeve. The locking tube has a one-way fixing mechanism mounted on its inner surface for engagement with the bolt. The mechanism permits movement of the tube along the bolt in the direction in which the split profile tapers, but resists movement in the opposite direction by engagement with the bolt. The locking tube can be made out of a plurality of circumferentially adjacent tubular segments, but preferably it is split only along a portion of its length, with the section remote from the taper being solid.

One preferred fixing mechanism takes the form of an O-ring mounted in an inwardly facing groove of the tube. The wall of the groove facing away from the taper is frusto-conical, and thus when the tube is urged in the direction away from the taper the O-ring is compressed between the frusto-conical wall and the bolt. The other wall of the groove may be formed by a ring itself fitted to the tube with a face substantially perpendicular to the tube axis and facing in the direction in which the split profile of the tube tapers.

Another fixing mechanism used in the invention comprises a plurality of inwardly directed circumferentially spaced pawls engaging the outer surface of the bolt. These are in continuous engagement with the bolt surface, and bite into the surface when the tube is urged in a direction opposite to its taper. The pawls can be integrally formed with the tube, but preferably they are separate elements, normally of a hard material, and may be fitted into axial slots in the end of the tube.

The invention will now be described by way of example and with reference to the accompanying schematic drawings wherein:

Figure 1 shows in diagrammatic cross-section, the fitting of a rockbolt and spreader plate in and against a substrate;

Figure 2 shows an enlarged cross-sectional view of the mechanism locking the spreader plate in place in the assembly of Figure 1;

Figures 3a and 3b show further enlarged detailed views of the fixing mechanism of Figure 2;

Figure 4 shows a view similar to that of Figure 3a, but illustrating an alternative fixing mechanism; and

Figure 5 shows a modification of the fixing mechanism of Figure 4.

As shown in Figure 1, a rockbolt 2 is fitted in a substrate 4, and holds a spreader plate 6 thereagainst by means of a taper cone 8 and a wedge 10 mounted on the rockbolt 2. The rockbolt 2 is fitted in a borehole 12 in the substrate 4, which is filled with resin 14. When the resin is cured, the rockbolt is secure.

Figure 2 illustrates how the wedge 10 serves to lock the taper cone 8 against the spreader plate 6, and thereby the spreader plate 6 against the substrate 4. The wedge 10 takes the form of a partially split tube (the split is shown in outline) with the tapered end being received in the end of the taper cone 8. The taper cone 8 can be formed with an internal profile which directly complements the taper on the wedge, but this is not necessary in order to securely lock the assembly. At the end of the wedge or tube 10 remote from the taper, it is formed with

an inwardly directed groove 16 in which is mounted an O-ring 18. The O-ring 18 is held in the groove 16 by a ring 20 as is better illustrated in Figures 3a and 3b. As can be seen, the wall 22 facing away from the taper has itself a reducing cross-section in the same sense as the taper, whereas the opposite wall 24 formed by the ring 20 is substantially perpendicular to the wedge or tube axis. Thus, when the wedge 10 is fitted the face 24 on the ring 20 pushes the O-ring 18 towards the taper cone 8, and in due course the engagement of the wedge with the taper cone locks, clamping the spreader plate 6 against the substrate 4. In this respect it should be noted that in practice the cross-section of the O-ring 18 is rather larger than shown. It will always be slightly compressed, even when the wedge is first fitted and the fixing mechanism inactive.

As a consequence of movement and vibration and for other reasons it is common for the substrate 4 to swell relatively soon after a rockbolt is installed, which imposes pressure on the spreader plate 6 and applies tensile stress to the rockbolt 2. This urges the wedge in a direction back along the rockbolt 2, effectively away from the substrate 4. When this happens, the O-ring 18 is compressed between the conical wall 22 of the groove in the wedge 10, and the wall of the rockbolt itself, as shown in Figure 3b.

An alternative fixing mechanism is shown in Figure 4. Here, rather than an O-ring, a number of pawls 26 are formed at the non-taper end of the wedge 10, which pawls 20 are themselves in engagement with the rockbolt 2. The pawls 26 are inclined away from the tapered end of the wedge 10 such that they can move along the surface of the rockbolt as the wedge or tube is fitted and secured, broadly in the manner described above, in the taper cone 8 to hold the spreader plate 6 against the substrate 4. When, as a result of movement of vibration, forces act on the wedge or tube 10 to urge it away from the substrate, the pawls 26 bite into the rockbolt surface to prevent such movement. Typically, there are eight such pawls 26 spaced around the internal periphery of the wedge or tube.

The pawls of the embodiment of Figure 4 can be formed integrally with the wedge or tube 10. Alternatively, they can be manufactured separately and fitted into axial slots or recesses in the tube. Typically, there are eight such pawls around a rockbolt of say 3 to 5 cms in diameter.

In the use of assemblies of the invention it should be understood that the fixing mechanism is initially inactive. The rockbolt is installed as described, and the spreader plate and taper cone fitted over the exposed end. The taper wedge is then fitted on the rockbolt end, and normally hammered along the bolt into the taper cone to set the assembly. At this stage the fixing mechanism is inactive. However, as the assembly resists movement of the substrate, the cone and wedge come under pressure from the spreader plate which forces the wedge along the rockbolt. At this point the fixing mechanism is activated, and the result is that the wedge is locked on the rockbolt. The pressure from the spreader plate continues to urge the taper cone over the wedge, further tightening the assembly. Having performed its task, and tightened an already tight assembly, the fixing mechanism is redundant. O-rings have a limited useful life, and pawls of the kind described lose their effectiveness with time. This makes these devices eminently suitable for use in assemblies of the present invention.

For reasons of safety, all the components of rockbolt assemblies according to the invention are made from non-metallic materials. This precludes sparking and therefore reduces the risk of fire. Typically the components are made from plastics resins, reinforced where necessary and appropriate.

Claims

1. A rockbolt assembly comprising a bolt for securement in a substrate with an end length projecting therefrom; a spreader plate for fitting over the end length and engaging the surface of a substrate around the rockbolt; a sleeve for mounting on the rockbolt and engaging the spreader plate; and a locking tube which locking tube has a split tapering profile to be received in the sleeve; the locking tube having a one-way fixing mechanism mounted on its inner surface for engagement with the bolt, the mechanism permitting movement of the tube along the bolt in the direction in which the split profile tapers, but resists movement in the opposite direction by engagement with the bolt.

2. An assembly according to Claim 1 wherein the locking tube comprises a plurality of circumferentially adjacent tubular segments.

3. An assembly according to Claim 1 or Claim 2 wherein the fixing mechanism comprises an O-ring mounted in an inwardly facing groove of the tube, the groove having a conical wall facing in said opposite direction whereby movement of the tube in said opposite direction compresses the O-ring between the bolt and the conical wall.

4. An assembly according to Claim 3 wherein the mechanism includes a ring fitted in the groove, which ring has a face substantially perpendicular to the tube axis which forms the wall of the groove facing in the direction in which the split profile of the tube tapers.

5. An assembly according to Claim 1 or Claim 2 wherein the fixing mechanism comprises a plurality of inwardly directly circumferentially spaced pawls engaging the outer surface of the bolt.

6. An assembly according to Claim 5 wherein the pawls are integrally formed with tubes.

7. An assembly according to Claim 5 wherein the pawls are separate elements fitted to the tubes.

8. An assembly according to Claim 7 wherein the pawls are fitted in axial slots formed in the end of the tubes.

Fig.1.

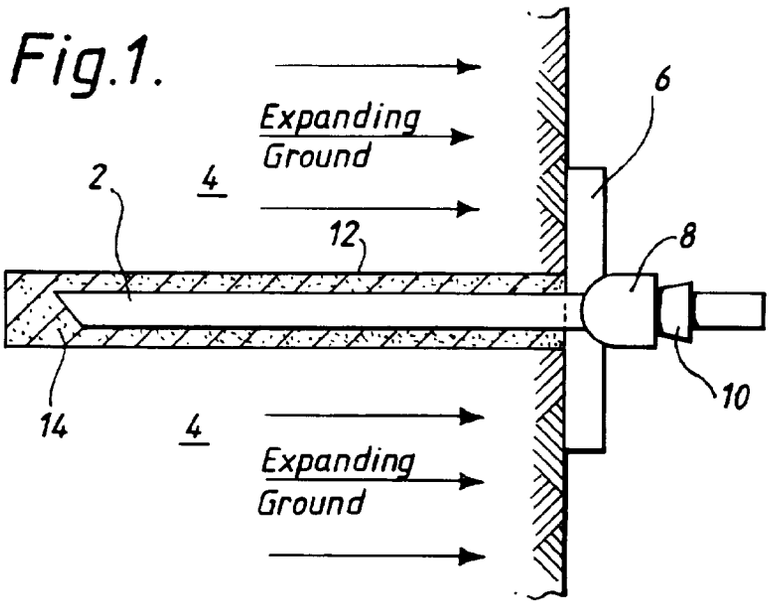


Fig.2.

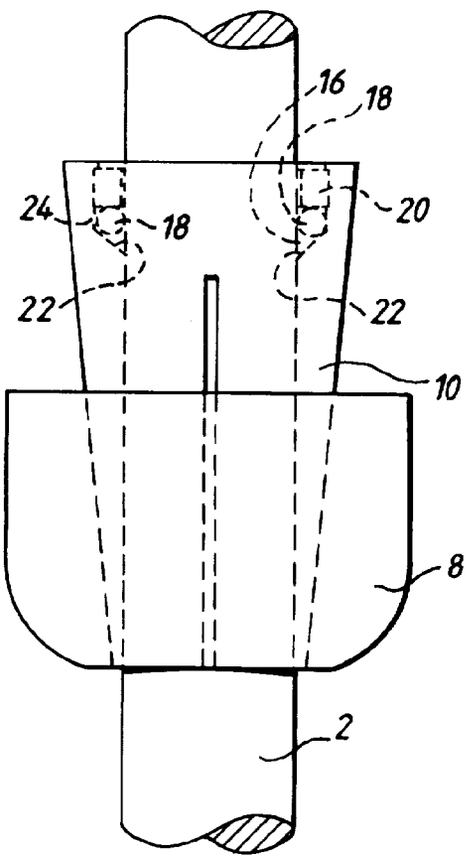
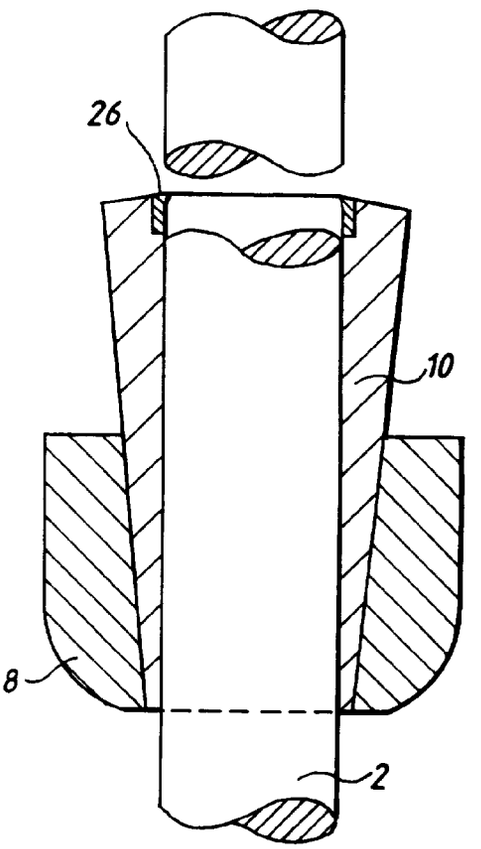


Fig.5.



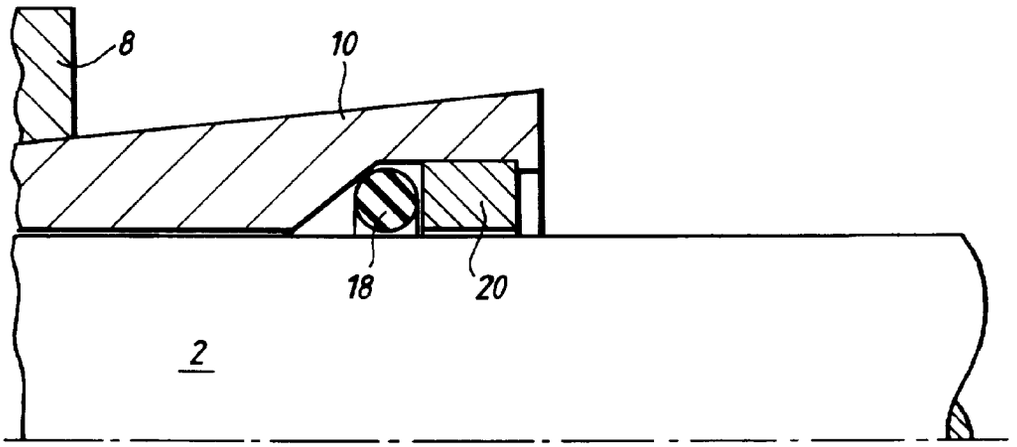


Fig.3A.

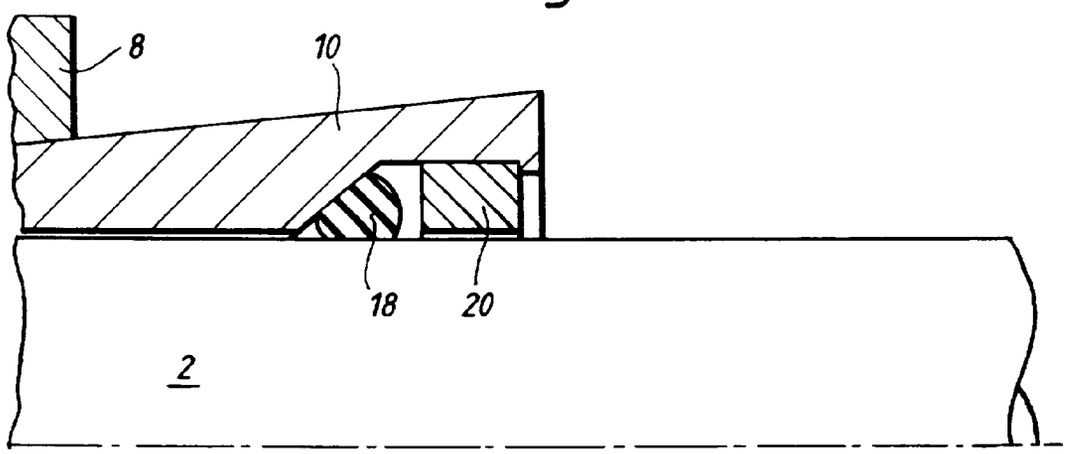


Fig.3B.

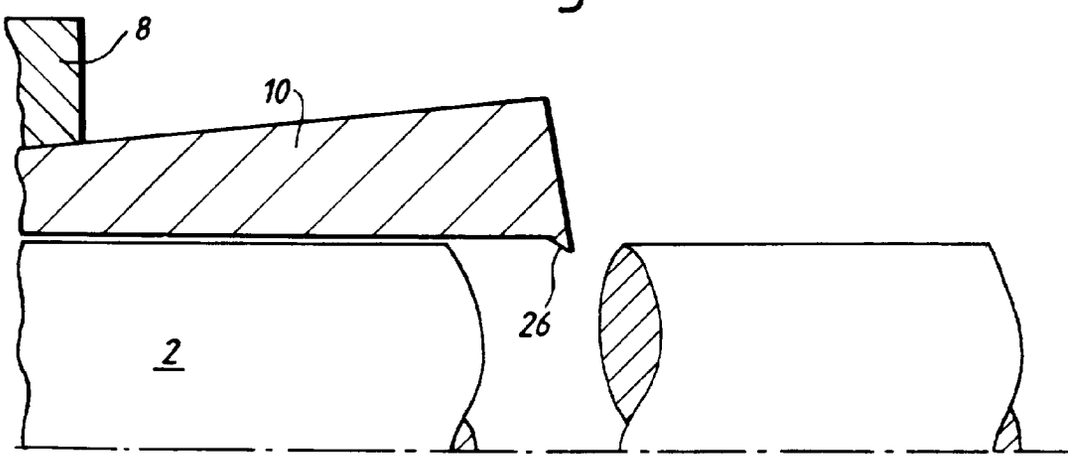


Fig.4.

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EUROPEAN SEARCH REPORT

Application Number
EP 98 30 2325

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	WO 97 08430 A (CARRINGTON WELDGRIP LTD ;GLOVER FRANK (GB); SCOTT CHRISTOPHER (GB)) 6 March 1997 * abstract; figures 1-5 *	1	E21D21/00
A	GB 2 199 105 A (BERGWERKSVERBAND GMBH) 29 June 1988 * figures *	1	
A	DE 195 17 257 A (WILLICH F BERG BAUTECHNIK ;ATP SRL AVANZATE TECNICHE DIE (IT)) 14 November 1996 * figures *	1	
A	FR 1 209 949 A (S.T.U.P.) 4 March 1960		
A	FR 1 158 055 A (STRESSTEEL CORP.) 6 June 1958		
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			E21D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	15 May 1998	Fonseca Fernandez, H

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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