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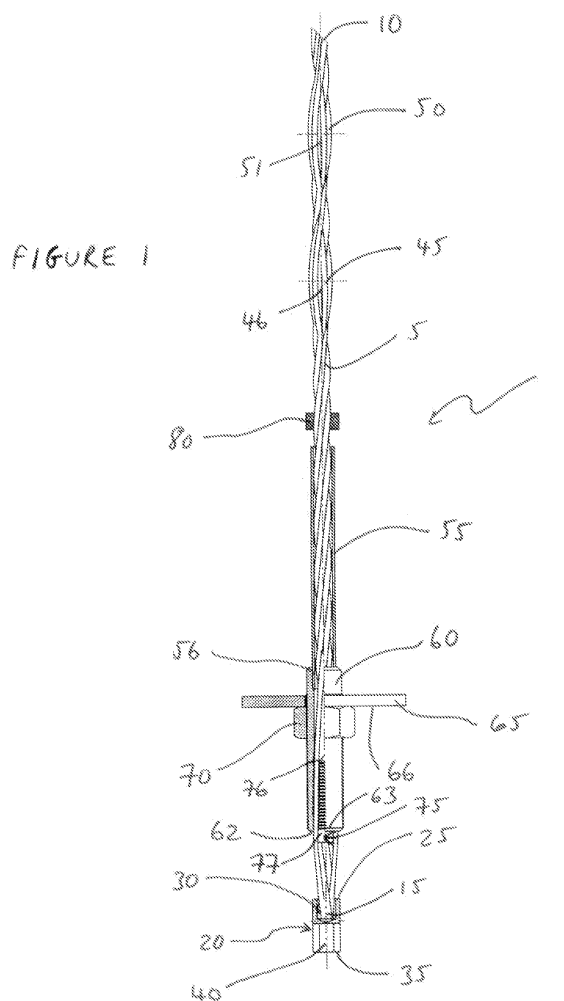
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(54) **CABLE BOLT**

(57) This invention relates to a cable bolt (1) for use in rock bolting and a method for its installation. The cable bolt (1) comprises a cable (5), a supporting tube (55) surrounding part of the cable (5), and an adapter (20) for receiving a drive tool for rotationally driving the cable bolt (1) into a hole. The supporting tube (55) has a length which is sufficient to substantially prevent cable buckling when the cable (5) is driven into the hole by the drive tool.



Description

[0001] This invention relates to a cable bolt for use in supporting walls and roofs of underground excavations such as mines.

[0002] A common method of installing a cable bolt involves drilling a hole into the wall or roof of a mine/excavation. One or more frangible resin capsules are then inserted as far as possible into the hole. The cable bolt is then inserted into the hole such that the cable pierces the resin capsules. Each resin capsule may comprise two or more components in separate compartments which solidify when they are mixed (eg by the cable piercing the compartments). The resin then solidifies, securing the cable bolt in the hole. The cable bolt includes a faceplate through which the cable passes. The faceplate is placed against the wall or roof of the mine/excavation around the mouth of the hole. The cable can then be tensioned and further resin can be injected into the hole as required by the user.

[0003] The step of inserting the cable bolt into the hole is normally carried out by a drive tool such as a drill. An adapter is normally fitted to the end of the cable bolt that is to protrude from the hole once the cable bolt has been installed. The drill is provided with a drill bit which fits into the adapter. The cable bolt is then driven into the hole by turning on the drill. This rotates the drill bit, the adapter and therefore the cable of the cable bolt. However, a problem with this method is that because the cable is flexible it can flail and buckle as it is driven into the hole. This makes the step more difficult for the person installing the cable bolt, as well as creating a risk of injury to this person and anyone else nearby. In addition, this can result in incomplete mixing of the components in the resin capsule as the cable pierces the capsule, for example because the resin capsule is not fully pierced by the cable bolt.

[0004] The step of tensioning the cable of the cable bolt can also cause difficulties for the person installing the bolt.

[0005] A way of ameliorating these problems has been sought.

[0006] According to the present invention there is provided a cable bolt for use in rock bolting comprising:

- (a) a cable;
- (b) a supporting tube surrounding part of the cable; and
- (c) an adapter for receiving a drive tool for rotationally driving the cable bolt into a hole,

wherein the supporting tube has a length which is sufficient to substantially prevent cable buckling when the cable bolt is driven into the hole by the drive tool. This helps the cable bolt fully pierce one or more resin capsules that have been placed in the hole. In connection with the present invention, the term "cable" is used to mean a two or more wires or ropes which are bonded,

twisted or braided together.

[0007] In some embodiments, the hole is formed in a surface of an excavation in a rock and the supporting tube has a length which is between 50% and 80% of the distance from the surface to an opposite surface of the excavation. The surface may be a wall or roof of an excavation. When the hole is formed in the roof of an excavation and the opposite surface is the floor of the excavation, this distance is also known as the "excavation height". In some embodiments, the supporting tube has a length which is approximately 2/3 of the distance from the surface to an opposite surface of the excavation. In some embodiments, the total length of the cable bolt is 3m-15m, for example 4m, 6m, 6.5m, 8m or 12m. In some embodiments, the diameter of the cable is between 10 and 30mm, preferably between 15.5 and 18.0mm.

[0008] In some embodiments, a tensioning tube is provided at a distal end of the supporting tube. In some embodiments, the tensioning tube and the supporting tube have a combined length which is between 50% and 80%, preferably approximately 2/3, of the distance from the surface to an opposite surface of the excavation. In some embodiments, the distal end of the supporting tube is inserted into a proximal end of the tensioning tube. In some embodiments, the supporting tube has an external diameter which is substantially the same as an internal diameter of the tensioning tube. In connection with the present invention, the term "distal" is used to mean closest to the end of the cable bolt that, in use, would protrude from the drilled hole. In connection with the present invention, the term "proximal" is used to mean closest to the end of the cable bolt that, in use, would be inserted furthest into the drilled hole.

[0009] In some embodiments, the cable is secured in the supporting tube or in the tensioning tube by a tapered stopper which is insertable into the supporting tube or into the tensioning tube and inside an unbonded, untwisted and/or unbraided section of the cable to press the unbonded, untwisted and/or unbraided section of the cable against an interior surface of the supporting tube or the tensioning tube. In some embodiments, the tapered stopper is inserted into the distal end of the supporting tube or distal end of the tensioning tube. In some embodiments, the tapered stopper is conical.

[0010] In some embodiments, the adapter comprises a recess for receiving the drive tool. In some embodiments, the recess is non-circular. In some embodiments, the recess is hexagonal.

[0011] In some embodiments, the cable has one or more unbonded, untwisted and/or unbraided sections in the form of a cage. By covering these sections with resin when installing the cable bolt, they can assist in securing the cable bolt in the hole.

[0012] In some embodiments, a seal is provided around the cable for retaining resin in the hole. A seal is particularly useful where the viscosity of the resin is sufficiently low that it would otherwise drip out of the hole. In some embodiments, the seal is made from a resiliently

deformable material, preferably rubber. In some embodiments, the seal is a sealing ring. In some embodiments, the seal has a diameter which is at least 90% of the diameter of the hole. In some embodiments, the seal has a diameter which is substantially the same as the diameter of the hole. In some embodiments, the seal is provided around the cable between a proximal end of the supporting tube and a proximal end of the cable.

[0013] In some embodiments, a faceplate extending in a direction perpendicular to the cable is provided on and in sliding engagement with the supporting tube or with the tensioning tube such that either the supporting tube or the tensioning tube extends through the faceplate. In some embodiments, either the supporting tube or the tensioning tube is provided with a threaded section adjacent to a distal side of the faceplate and a nut threaded on the threaded section.

[0014] According to the present invention there is also provided a cable bolt for use in rock bolting comprising a cable and a supporting tube surrounding part of the cable, wherein the cable is secured in the supporting tube by a tapered stopper which is insertable into the supporting tube inside an unbonded, untwisted and/or unbraided section of the cable to press the unbonded, untwisted and/or unbraided section of the cable against an interior surface of the supporting tube.

[0015] In some embodiments, a tensioning tube is provided at a distal end of the supporting tube and the tapered stopper is insertable into the tensioning tube inside an unbonded, untwisted and/or unbraided section of the cable to press the unbonded, untwisted and/or unbraided section of the cable against an interior surface of the tensioning tube. In some embodiments, the tapered stopper is inserted into the distal end of the tensioning tube. In some embodiments, the tapered stopper is conical. In some embodiments, the cable bolt comprises an adapter for receiving a drive tool for rotationally driving the cable bolt into a hole. In some embodiments, the supporting tube has a length which is sufficient to substantially prevent cable buckling when the cable bolt is driven into the hole by the drive tool.

[0016] According to the present invention there is also provided a combination of:

- (a) a cable bolt for use in rock bolting comprising a cable, a supporting tube surrounding part of the cable, and an adapter for receiving a drive tool for rotationally driving the cable bolt into a hole, wherein the supporting tube has a length which is sufficient to substantially prevent cable buckling when the cable bolt is driven into the hole by the drive tool; and
- (b) instructions for using the cable bolt.

[0017] In some embodiments, the instructions specify that in use the hole is formed in a surface of an excavation in a rock and the length of the supporting tube should be between 50% and 80%, preferably, 2/3, the distance from the surface to an opposite surface. In some embodi-

ments, a tensioning tube is provided at a distal end of the supporting tube. In some embodiments, the tensioning tube and the supporting tube have a combined length which is between 50% and 80%, preferably approximately 2/3, of the distance from the surface to an opposite surface of the excavation.

[0018] According to the present invention there is also provided a method of installing a cable bolt for use in rock bolting, the cable bolt comprising a cable, a supporting tube surrounding part of the cable, the supporting tube having a length which is sufficient to substantially prevent cable buckling when the cable bolt is driven into the hole by the drive tool, and an adapter for receiving a drive tool for rotationally driving the cable bolt into a hole, the method comprising the steps of:

- (a) forming a hole in a rock;
- (b) driving the cable bolt into the hole using the drive tool; and
- (c) securing the cable bolt in the hole.

[0019] In some embodiments, the hole is formed in a surface of an excavation in a rock and the length of the supporting tube is between 50% and 80%, preferably, 2/3, the distance from the surface to an opposite surface. In some embodiments, the method comprises between steps (a) and (b) the step of inserting one or more frangible resin capsules into the hole. In some embodiments, the step of driving the cable bolt into the hole comprises piercing the one or more frangible resin capsules.

[0020] In some embodiments, a tensioning tube is provided at a distal end of the supporting tube. In some embodiments, the tensioning tube and the supporting tube have a combined length which is between 50% and 80%, preferably approximately 2/3, of the distance from the surface to an opposite surface of the excavation. In some embodiments, a faceplate extending in a direction perpendicular to the cable is provided on and in sliding engagement with the supporting tube or with the tensioning tube such that either the supporting tube or the tensioning tube extends through the faceplate. In some embodiments, the step of securing the cable bolt in the hole comprises curing the resin, placing the faceplate around the mouth of the hole and tensioning the cable. In some embodiments, the supporting tube or the tensioning tube is provided with a threaded section adjacent to a distal side of the faceplate and a nut threaded on the threaded section and the cable is tensioned by screwing the nut proximally towards the faceplate. In some embodiments, resin is added to the hole after the cable has been tensioned.

[0021] According to the present invention there is also provided a combination of a cable bolt for use in rock bolting and a hole in a rock, the cable bolt comprising a cable, a supporting tube surrounding part of the cable, and an adapter for receiving a drive tool for rotationally driving the cable bolt into the hole, wherein the supporting tube has a length which is sufficient to substantially pre-

vent cable buckling when the cable bolt is driven into the hole by the drive tool. In some embodiments, the hole is formed in a surface of an excavation in a rock and the length of the supporting tube is between 50% and 80%, preferably, $2/3$, the distance from the surface to an opposite surface. In some embodiments, a tensioning tube is provided at a distal end of the supporting tube. In some embodiments, the tensioning tube and the supporting tube have a combined length which is between 50% and 80%, preferably approximately $2/3$, of the distance from the surface to an opposite surface of the excavation..

[0022] According to the present invention there is also provided a rock bolting kit comprising:

- (a) a cable bolt comprising a cable, a supporting tube surrounding part of the cable, and an adapter for receiving a drive tool for rotationally driving the cable bolt into a hole;
- (b) a drill bit for forming a hole of a predetermined depth in a rock; and
- (c) a resin capsule for securing the cable bolt in the hole,

wherein the supporting tube has a length which is sufficient to substantially prevent cable buckling when the cable bolt is driven into the hole by the drive tool. In some embodiments, hole is formed in a surface of an excavation in a rock and the length of the supporting tube is between 50% and 80%, preferably, $2/3$, the distance from the surface to an opposite surface. In some embodiments, a tensioning tube is provided at a distal end of the supporting tube. In some embodiments, the tensioning tube and the supporting tube have a combined length which is between 50% and 80%, preferably approximately $2/3$, of the distance from the surface to an opposite surface of the excavation..

[0023] This invention also relates to a cable bolt and a method of its installation that can be used for underground excavation in mines that produce hard coal or ores of non-ferrous metals. The cable bolt may be used in high roof bolting in roadways and crossings, as well as to provide additional support in excavations with independent roof bolt support where separation of rock strata occurs above the anchored bolts.

[0024] The cable bolt of the present invention is preferably designed to support an excavation of standard height, ie around 2m to 4m. However, the cable bolt of the present invention can also be used to support excavations with greater heights. The sealed cable bolts may provide independent or auxiliary roof support. The existing technology of roof bolting using cable bolts involves the introduction of a bolt into an already drilled borehole and then filling the borehole with a sealant, adhesive or cement grout. Previous attempts to install cable bolts into holes pre-filled with frangible resin capsules have failed. A reason for this was buckling (deviation from the vertical line) of the cable between the excavation roof and the roof bolting equipment during execution of the advancing

and rotary movement which is used to drive the cable bolt into the hole.

[0025] The present invention relates to an installation method for a cable bolt in which resin capsules are preferably placed inside pre-drilled boreholes. Preferably the cable bolt is then inserted into the borehole with simultaneous advancing and rotation movements in order to disrupt the resin capsule(s) and mix the resin components therein. Preferably, the cable bolt is then left in the borehole until the resin has cured.

[0026] The cable bolt of the present invention is preferably made of a wire-stranded rope (ie a cable). The upper end of the cable is preferably beveled at one side. Cages are preferably formed in the upper part of the cable. The bottom part of the cable is preferably encased in a supporting tube with a tensioning tube that is slid onto the cable. The overall length of the tensioning tube along with the supporting tube is preferably about $2/3$ of the excavation height. The tensioning tube preferably incorporates a tapered stopper, where the combination of the tensioning tube and the tapered stopper acts as a clamp. The bottom end of the cable is preferably terminated with a hexagonal insertion nut. A tensioning nut with a faceplate is preferably placed on the tensioning tube.

[0027] Providing a cable bolt with a supporting tube provided with a tensioning tube that encases the cable can reduce the effect of cable buckling (side deviations) during the advancing and rotation movements. It can allow the use of the reverse installation method, which is different from the one that used to be characteristic for cable bolts. The strengthening member, i.e. the supporting tube, connected with the tensioning sleeve, can facilitate driving the cable into a borehole already drilled in a rock mass and it can increase the overall strength of the arrangement, in particular against horizontal forces. The application of cable bolts with this special design, installed by the sealing of the cable segment (ie where the cable inside the tube remains unsealed) can make the support system more flexible. Such a support system is particularly preferred for application in seams exposed to rockbursts. The use of a cage or cages in the upper part of the cable can result in better mixing of the resin components because the cages have a diameter which is larger than the diameter of the cable.

[0028] The implementation of a new type of insertion nut which is preferably permanently attached to the bottom end of the cable and used to enforce rotation of the cable can enable unhindered sliding of the nut towards the tensioning tube.

[0029] Cable bolts are preferably made of stranded wires and can have diameters of about a dozen millimeters, usually $\varnothing 15.5$ mm or $\varnothing 18$ mm. The upper end of the cable is preferably beveled at one side, which can facilitate disruption of resin capsules.

[0030] The cable, in its upper part, may be modified to achieve more advantageous distribution of forces that act onto the resin encapsulating the cable. For that pur-

pose the cable is preferably provided with cages having a length of approximately 100 mm and a diameter from 20 mm to 28 mm (22-24 mm for standard manufacturing), where the cage diameter depends on the borehole.

[0031] After being filled with the resin, the cages can act as rigid blisters and interact with the encapsulating resin. The resin inside the cages can remain uncrushed in spite of the significant loads that are applied to the cable. This is because the radial forces induced in the cable that would possibly crush the cured resin inside cages are substantially lower than the axial forces. Thus, the special shape of the cable can change the distribution of forces that act around the cable and which are induced by translocation of the cable against the surrounding rocks. The cages can impose significant forces that act perpendicularly to the borehole walls and compress the resin, which may result in a reduction of the forces that act parallel to the borehole walls and which could cause shearing of the cable. Consequently, cables provided with cages can provide firmer collaboration with the rock mass. A reason for this is that translocation of cables against the rock, caused by a unit load, is much less than that of a plain cable. In other words, the anchoring force provided by a cable having cages can be much higher than that of a plain cable of the same length.

[0032] The minimum Rm (tensile strength) of the cable material that is used to fabricate the cable bolt may be 1,400 MPa. Cages provided on the cable may also contribute to the better mixing of the components that make up the resin capsules. The bottom part of the cable is preferably encased by the supporting tube and the tensioning tube along with the tapered stopper which acts as the cable clamp. The bottom end of the cable preferably terminates with the insertion nut that enables rotation of the cable. A rubber sealing gasket pulled onto the cable is preferably applied when cable bolts are installed using resin having a low viscosity. Preferably, a nut along with a faceplate is placed on the tensioning tube. The nut and faceplate are preferably designed for pre-tensioning of cable bolts after installation.

[0033] The application of the cable bolt at the location of its installation preferably consists primarily of the preparation of all the necessary materials (cables, faceplates, nuts, resin capsules) and drilling a borehole with sufficient diameter in accordance with the assumed bolting layout. Next, resin capsules of the required volumes are preferably inserted into borehole. The cable of the cable bolt is preferably then manually driven into the borehole so that the bottom end of the cable protrudes from the borehole. This enables further installation of the cable bolt with use of a rock bolting machine. The protruding cable of the cable bolt is preferably driven deeper and deeper into the borehole with advancing and rotating movements enforced by the rock bolting machine. This results in the mixing of the components of the resin capsules. After the curing of the resin, the main faceplate is preferably placed on the tensioning tube and tightened with the nut until the required torque is reached. Thus,

the pre-tensioning of the cable bolt can be achieved with an initial anchoring force which is preferably not less than 30 kN.

[0034] An application method of the cable bolt is characterized in that resin capsules are preferably inserted into an already drilled borehole. A cable bolt is preferably then driven into the borehole with advancing and rotation movements until components of the resin capsules are mixed. The cable bolt is preferably then left until the resin is cured. After the resin is cured, a main faceplate may be placed on the tensioning tube and then tightened with the nut until the required torque is reached in order to achieve the pre-tensioning of the cable bolt with the initial anchoring force which is preferably not less than 30 kN.

[0035] Disclosed herein is a cable bolt made of a cable. The upper end of the cable is preferably bevelled at one side and the upper part of the cable preferably has cages. A tensioning tube with a faceplate and a nut preferably encases a tapered stopper that may be used for cable clamping. The bottom end of the cable preferably has an insertion nut. In the bottom part of the cable is preferably encased by a supporting tube that is connected to a tensioning tube. The overall length of the tensioning tube along with the supporting tube is preferably about 2/3 of the excavation height.

[0036] The application method of a cable bolt preferably consists of insertion of resin capsules into already drilled boreholes. The cable bolt is preferably driven into the borehole with advancing and rotating movements in order to mix components of the resin capsules. After the resin has cured, the main faceplate may be placed on the tensioning tube and then tightened with the nut in order to achieve an initial anchoring force preferably not less than 30 kN.

[0037] In the bottom part of the cable is preferably encased by a supporting tube that is connected to the tensioning tube. The overall length of the tensioning tube along with the supporting tube is preferably about 2/3 of the excavation height.

[0038] The present invention will be further described in greater detail by reference to the following Figures of the accompanying drawings which is not intended to limit the scope of the invention claimed, in which:

Figure 1 shows a cable bolt according to one embodiment of the present invention.

Figure 2 shows the cable bolt of Figure 1 when installed in a hole in a surface of an excavation in a rock.

[0039] Figures 1 and 2 show a cable bolt 1 as it would appear when inserted into a drilled hole (not shown in Figure 1) in the roof of a mine. As shown in Figure 1, cable bolt 1 comprises cable 5. Cable 5 is formed of two or more metal wires bonded, twisted or braided together. Cable 5 has bevelled proximal end 10. The bevel helps to burst resin cartridges (not shown) placed in the drilled

hole before the cable bolt 1 is inserted into the hole. At the opposite end of cable 5 to bevelled proximal end 10 is provided distal end 15.

[0040] Distal end 15 of cable 5 is connected to insertion nut 20. Insertion nut 20 comprises a first, proximal, end 25 in which is formed cable recess 30. Cable 5 is attached to insertion nut 20 in cable recess 30, for example by welding, weld-soldering and/or swaging. Insertion nut 20 also comprises a second, distal, end 35 in which is formed hexagonal recess 40. Hexagonal recess 40 is shaped to receive a driving tool for rotating cable 5 and driving it into the drilled hole.

[0041] Cages 45,50 are formed in cable 5 close to bevelled proximal end 10. Cages 45,50 are slightly unbonded, untwisted or unbraided sections of the wires of cable 5, such that voids 46,51 are formed inside cages 45,50. In addition, there are gaps between the untwisted wires of cages 45,50 such that the resin (not shown) used to secure the cable bolt 1 in the drilled hole can pass through the gaps and into the voids 46,51. Although two voids 46,51 are shown in Figure 1, more or fewer voids can be provided depending on the requirements of the application.

[0042] On cable 5, between cages 45,50 and insertion nut 20, is provided supporting tube 55. Supporting tube 55 comprises a hollow metal cylinder which surrounds cable 5 in order to minimise sideways deviations of cable 5.

[0043] On cable 5, between cages 45,50 and supporting tube 55, is provided sealing gasket 80. Sealing gasket 80 is in the form of a rubber ring. In situations where the resin used to secure cable bolt 1 in the drilled hole has a relatively low viscosity, sealing gasket 80 is used to retain resin in the drilled hole.

[0044] At its distal end 56, supporting tube 55 is connected to tensioning tube 60. Tensioning tube 60 is also provided on cable 5 and is in the form of a hollow metal cylinder which surrounds cable 5. Tensioning tube 60 differs from supporting tube 55 in that it has a larger diameter than supporting tube 55 and is formed of a thicker layer of metal. Supporting tube 55 is connected to tensioning tube 60 by the insertion of its distal end 56 into tensioning tube 60. Supporting tube 55 is retained in tensioning tube 60 by friction because the outer diameter of supporting tube 55 is substantially the same as the internal diameter of tensioning tube 60. Supporting tube 55 can additionally be secured in tensioning tube 60 by welding, weld-soldering and/or swaging.

[0045] In sliding engagement with tensioning tube 60 is faceplate 65. Faceplate 65 has a central aperture which slidably engages tensioning tube 60. Faceplate 65 comprises a square, flat sheet of metal which extends in a direction perpendicular to the axis of cable 5. When cable bolt 1 is inserted into a drilled hole in the roof of a mine, faceplate 65 is placed against the surface of the roof surrounding the mouth of the drilled hole.

[0046] Tensioning nut 70 is provided on tensioning section 60 on distal side 66 of faceplate 65. The threaded

aperture (not shown) of tensioning nut 70 is screwed onto a corresponding threaded portion (not shown) of the external surface 61 of tensioning tube 60.

[0047] Inserted into distal end 62 of tensioning tube 60 is conical stopper 75. Conical stopper 75 has a narrower proximal end 76 and a wider distal end 77. Conical stopper 75 is seated inside the wires of cable 5 in an untwisted section similar to cages 45,50. In this way, the wires of cable 5 are secured between conical stopper 75 and the edge of opening 63 of distal end 62 of tensioning tube 60.

[0048] During the installation of cable bolt 1, a hole (not shown in Figure 1) is drilled in, for example, the roof of a mine. One or more resin cartridges are then inserted into the hole and pushed to the closed, proximal, end of the hole. The cable bolt 1 is then initially manually inserted into the drilled hole. A hexagonal drill bit (not shown) on a drive tool (not shown), for example a drill, is then inserted into the hexagonal recess 40 of insertion nut 20. The drive tool is then used to rotationally drive the cable bolt 1 into the hole. This movement bursts the one or more resin cartridges and causes the resin contained in them to cure, ie to solidify. This secures the cable bolt 1 in the drilled hole.

[0049] The supporting tube 55 and tensioning tube 60 (connected to each other), faceplate 65 and tensioning nut 70 provided on cable 5 are then slid proximally such that the faceplate contacts the roof of the mine surrounding the mouth of the drilled hole. Conical stopper 75 is then inserted into distal end 62 of tensioning tube 60 inside an untwisted section of cable 5 such that the wires of cable 5 are pressed against the edge of opening 63 of distal end 62 of tensioning tube 60. In this way, the position of the supporting 55 and tensioning 60 tubes relative to the cable 5 is secured.

[0050] Tensioning nut 70 is then screwed proximally on threaded portion (not shown) of the external surface 61 of tensioning tube 60 towards faceplate 65. In this way, the cable 5 is tensioned relative to faceplate 65.

[0051] In some embodiments, the faceplate 65 may be provided with a resin aperture (not shown). This is so that, after the cable 5 has been tensioned, additional resin may be delivered through the resin aperture into the drilled hole. This can be done in order to fill any voids in the drilled hole with resin, as well as to minimise the possibility of the tension in cable 5 decreasing after the cable bolt 1 has been installed.

[0052] Figure 2 shows the cable bolt 1 when installed in a drilled hole 100 in a surface 105 of an excavation 110 in a rock. Excavation 110 also includes opposite surface 115, which is opposite surface 105. The cable bolt 1 in Figure 2 is identical to that shown in Figure 1. However, for ease of reference, in Figure 2 most of the individual parts of the cable bolt 1 are not labelled.

[0053] As shown in Figure 2, cable bolt 1 is installed in substantially cylindrical drilled hole 100 using resin (not shown) as discussed above. The length of cable bolt 1 is labelled A. The distance from surface 105 to an opposite surface 115 of excavation 110 is labelled B. In Figure

2, surface 105 is the roof of the excavation and opposite surface 115 is the floor of the excavation. Thus, distance B is the excavation height. The length of the supporting tube 55 (see Figure 1) is labelled C. The depth of drilled hole 100 is labelled D. The length of the part of the cable bolt 1 that protrudes from drilled hole 100 is labelled E. The length of cable 5 (see Figure 1) that protrudes from supporting tube 55 is labelled F.

[0054] In the embodiment shown in Figure 2, the lengths A-E are as follows:

A = 5m
B = 3m
C = 2m
D = 4.8-5m
E = 0.2m
F = 2.8m

Thus, the length of the supporting tube 55 (C, 2m), is 2/3 of the distance (B, 3m) from surface 105 to opposite surface 115 of excavation 110. Also, since the tensioning tube 60 only protrudes a small amount (less than 0.2m) from the hole, the tensioning tube and the supporting tube have a combined length which is approximately 2/3 of the distance from surface 105 to opposite surface 115 of excavation 110.

[0055] In an alternative embodiment, the lengths A-E are as follows:

A = 8m
B = 4m
C = ~2.7m
D = 7.8-8m
E = 0.2m
F = ~5.1m

Again, the length of the supporting tube 55 (C, ~2.7m), is 2/3 of the distance (B, 4m) from surface 105 to opposite surface 115 of excavation 110. Similarly, since the tensioning tube 60 only protrudes a small amount (less than 0.2m) from the hole, the tensioning tube and the supporting tube have a combined length which is approximately 2/3 of the distance from surface 105 to opposite surface 115 of excavation 110.

As shown in Figure 2, sealing gasket 80 has a diameter which is substantially the same as the diameter of drilled hole 100. In this way, sealing gasket 80 can prevent the relatively viscous resin used to install the cable bolt 1 in the drilled hole 100 from dripping out of the drilled hole 100 under gravity.

Claims

1. A cable bolt for use in rock bolting comprising:
 - (a) a cable;
 - (b) a supporting tube surrounding part of the ca-

ble; and

(c) an adapter for receiving a drive tool for rotationally driving the cable bolt into a hole ,

- 5 wherein the supporting tube has a length which is sufficient to substantially prevent cable buckling when the cable bolt is driven into the hole by the drive tool.
- 10 2. A cable bolt as claimed in claim 1, wherein the hole is formed in a surface of an excavation in a rock and the supporting tube has a length which is between 50% and 80% of the distance from the surface to an opposite surface of the excavation.
- 15 3. A cable bolt as claimed in any one of the preceding claims, wherein a tensioning tube is provided at a distal end of the supporting tube.
- 20 4. A cable bolt as claimed in claim 3, wherein the supporting tube and the tensioning tube have a combined length which is approximately 2/3 the distance from the surface to the opposite surface of the excavation.
- 25 5. A cable bolt as claimed in claim 3 or claim 4, wherein the cable is secured in the tensioning tube by a tapered stopper which is insertable into the tensioning tube and inside an unbonded, untwisted or unbraided section of the cable to press the unbonded, untwisted or unbraided section of the cable against an interior surface of the tensioning tube.
- 30 6. A cable bolt as claimed in any one of the preceding claims, wherein the adapter comprises a recess for receiving the drive tool.
- 35 7. A cable bolt as claimed in any one of the preceding claims, wherein the cable has one or more unbonded, untwisted and/or unbraided sections in the form of a cage.
- 40 8. A cable bolt as claimed in any one of the preceding claims, wherein a seal is provided around the cable for retaining resin in the hole.
- 45 9. A cable bolt as claimed in any one of claims 3 to 5, wherein a faceplate extending in a direction perpendicular to the cable is provided on and in sliding engagement with the tensioning tube such that the tensioning tube extends through the faceplate.
- 50 10. A cable bolt as claimed in claim 9, wherein the tensioning tube is provided with a threaded section adjacent to a distal side of the faceplate and a nut threaded on the threaded section.
- 55 11. A cable bolt for use in rock bolting comprising a cable

and a supporting tube surrounding part of the cable, wherein the cable is secured in the supporting tube by a tapered stopper which is insertable into the supporting tube inside an unbonded, untwisted and/or unbraided section of the cable to press the unbonded, untwisted and/or unbraided section of the cable against an interior surface of the supporting tube.

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12. The combination of a

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- (a) a cable bolt for use in rock bolting comprising a cable, a supporting tube surrounding part of the cable, and an adapter for receiving a drive tool for driving the cable bolt into a hole, wherein the supporting tube has a length which is sufficient to substantially prevent cable buckling when the cable bolt is rotationally driven into the hole by the drive tool; and
- (b) instructions for using the cable bolt.

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13. A method of installing a cable bolt for use in rock bolting, the cable bolt comprising a cable, a supporting tube surrounding part of the cable, the supporting tube having a length which is sufficient to substantially prevent cable buckling when the cable bolt is driven into the hole by the drive tool, and an adapter for receiving a drive tool for rotationally driving the cable bolt into a hole, the method comprising the steps of:

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- (a) forming a hole in a rock;
- (b) driving the cable bolt into the hole using the drive tool; and
- (c) securing the cable bolt in the hole.

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14. The combination of a cable bolt for use in rock bolting and an hole in a rock, the cable bolt comprising a cable, a supporting tube surrounding part of the cable, and an adapter for receiving a drive tool for rotationally driving the cable bolt into the hole, wherein the supporting tube has a length which is sufficient to substantially prevent cable buckling when the cable bolt is driven into the hole by the drive tool.

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15. A rock bolting kit comprising:

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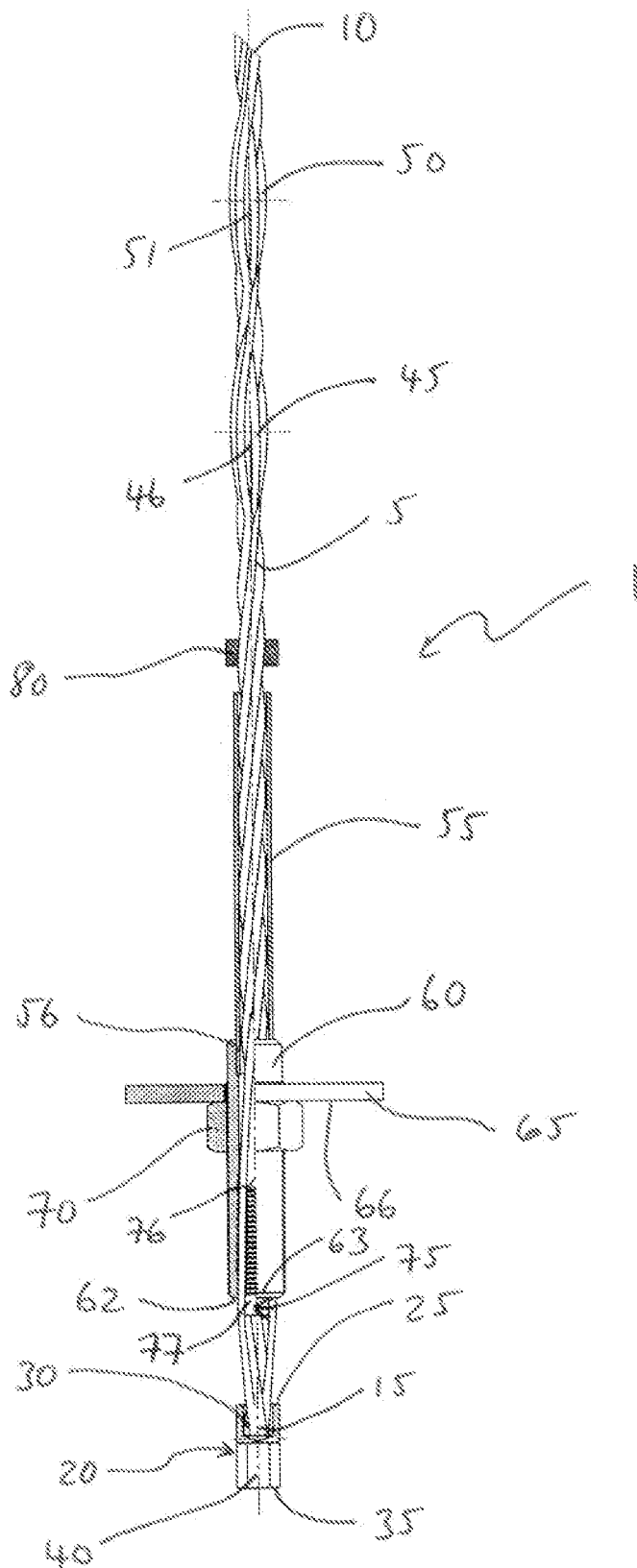
- (a) a cable bolt comprising a cable, a supporting tube surrounding part of the cable, and an adapter for receiving a drive tool for rotationally driving the cable bolt into a hole;
- (b) a drill bit for forming a hole of a predetermined depth in a rock; and
- (c) a resin capsule for securing the cable bolt in the hole,

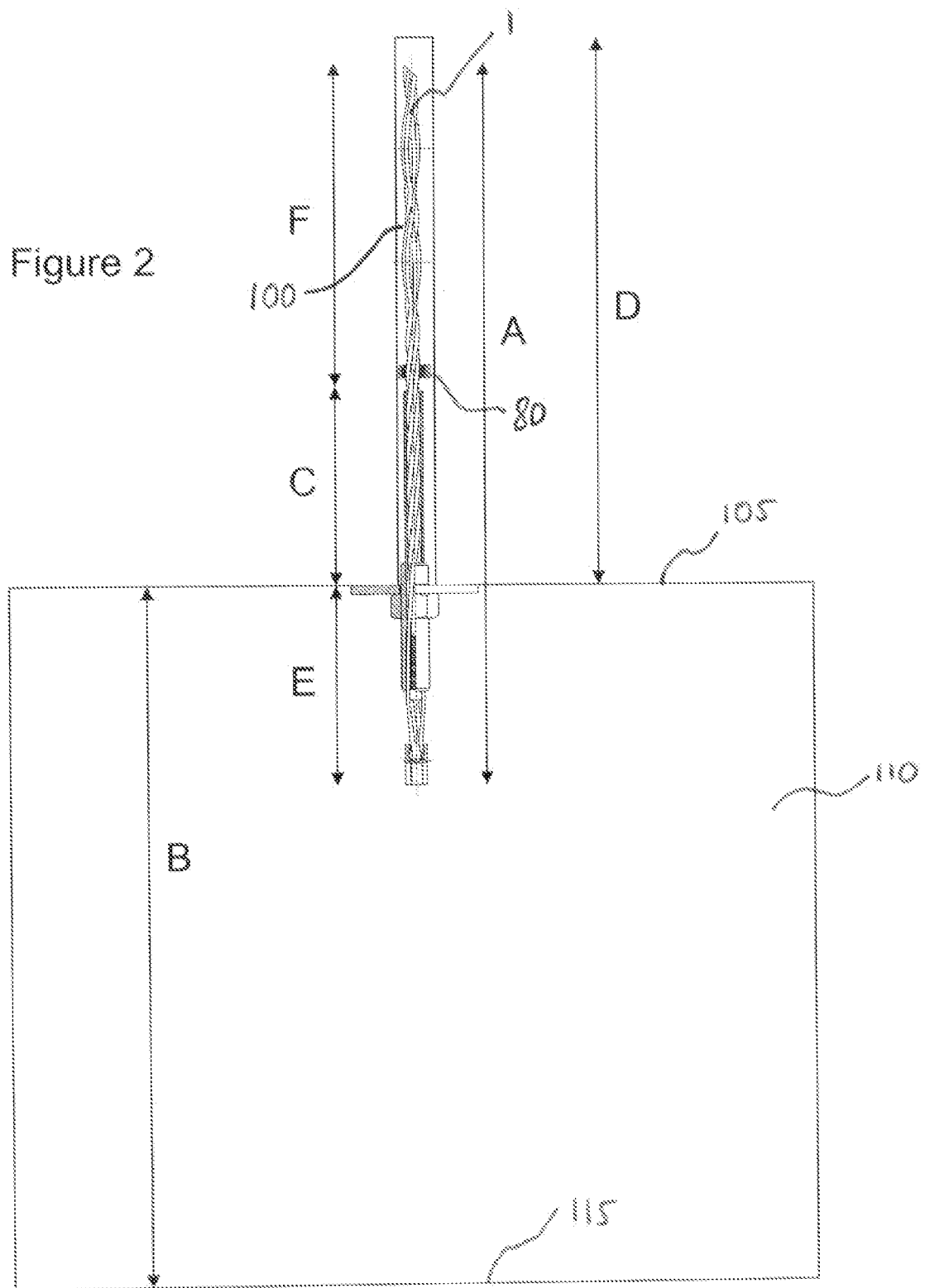
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wherein the supporting tube has a length which is sufficient to substantially prevent cable buckling when the cable bolt is driven into the hole by the

FIGURE 1







EUROPEAN SEARCH REPORT

Application Number
EP 10 46 1521

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