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3,385,155

MINE ROOF BOLT EXPANSION ANCHOR

Filed June 17, 1966

3 Sheets-Sheet 1

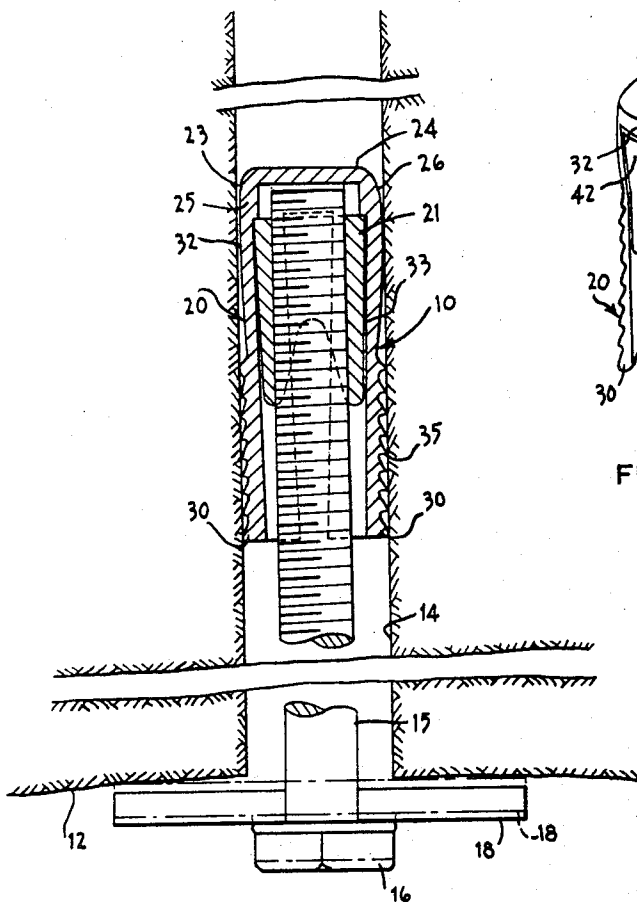


FIG. 1

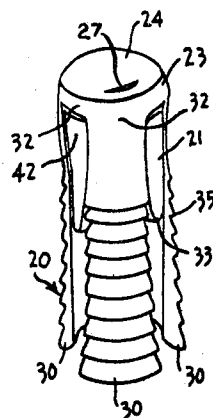


FIG. 2

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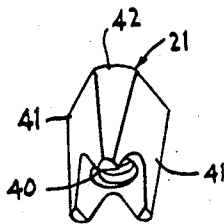


FIG. 3

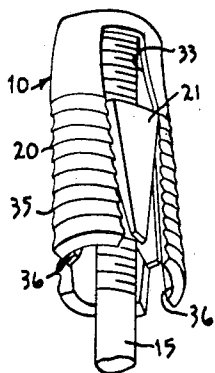


FIG. 4

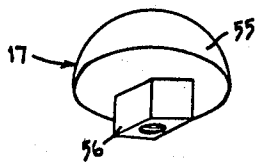
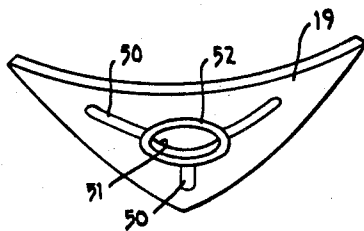


FIG. 5

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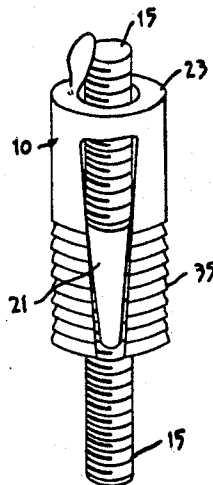
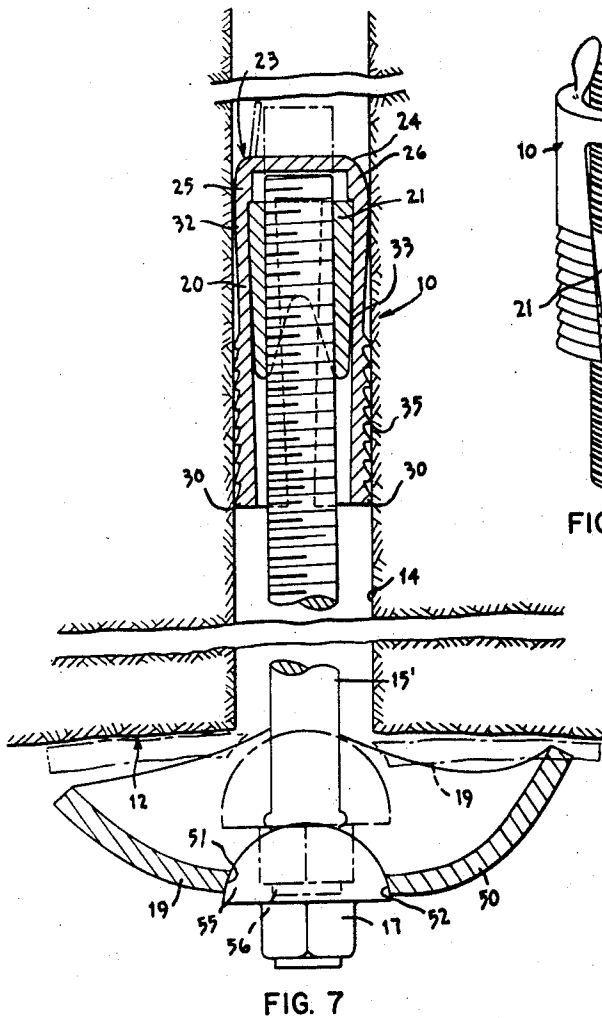
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3 Sheets-Sheet 3



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MINE ROOF BOLT EXPANSION ANCHOR

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948,279

1 Claim. (Cl. 85-62)

ABSTRACT OF THE DISCLOSURE

An improved rock anchor unit combining a strengthened crown structure and a triangular tension indicating washer.

This invention relates to mine roof bolts and more particularly to a roof bolt expansion anchor.

It is common practice in mining operations to use bolts inserted in holes drilled in the mine ceiling for supporting the mine roof or ceiling. This practice is popularly called rock bolting. It will be appreciated that a great variety of rock bolting techniques have been developed, and although this invention is not limited to the particular use described, it is desirable to discuss the advantages of the present invention in connection with a typical rock bolting method.

In one type of rock bolt installation, bolts which may be from three to six feet or more in length, are disposed in drilled holes extending into the rock or other roof strata. The bolt extends through an apertured steel plate or the like which engages the surface of the rock. An anchor unit is provided on the threaded upper end of the bolt.

The anchor unit is adapted to expand laterally as the bolt is tightened so as to firmly engage the sides of the drill hole. Further tightening of the bolt draws the steel plate tightly against the rocks and provides the desired tension in the bolt. In this manner a weak stratum may be bolted to a stronger stratum.

One type of anchor includes laterally spreadable sections or wings shaped to provide a generally cylindrical exterior for engagement in the drill hole. The wings are adapted to be moved radially outwardly by an expander plug threadedly received on the roof bolt. The expander plug and the wing portions have cooperating cam surfaces which move the wing portions outwardly when the plug is moved longitudinally relative to the wing portions. This longitudinal movement of the wedge plug is provided mainly by the tension developed in the bolt as the head of the bolt engages the apertured steel plate and the bolt is turned to reduce the effective length of the bolt.

The disadvantage of providing the longitudinal movement of the wedge in the foregoing manner is that it is possible for the wing portions to move down the bolt with the plug and little if any expansion of the anchor unit takes place. Such a situation could arise for example as the result of a portion of the bore being over sized.

The disadvantage can be overcome by providing the upper wing portions with a member or members adapted to engage the end of the bolt thereby ensuring movement of the wedge plug relative to the wing portions. The member adapted to be engaged by the end of the bolt must be strong enough to provide the desired longitudinal movement of the wedge plug. However, a further problem encountered is that of preventing misalignment of the wing portions or rupture of means provided for holding the wing portions together if the bolt is driven too far into the anchor so as to pass through the upper end of the anchor. It will be appreciated that this may quite easily happen due to the speed and power provided by the power driven torque wrenches generally employed in roof bolting operations.

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The present invention overcomes the above-mentioned disadvantages of the prior devices by providing a rock anchor unit including a shell comprising segments of a cylinder terminating at their normally upper ends in a crown having a strengthened shoulder portion, a wedge plug received between the segments of the shell, and a bolt threadedly received in said plug for moving the plug longitudinally to expand the shell. The crown structure being adapted to be engaged by the end of a bolt and being so dimensioned that upon the application of a predetermined force on the bolt required to expand the shell in a bore hole, the bolt may be driven through the crown structure without damaging the shoulder portion.

In the drawings which illustrate a preferred embodiment of the invention:

FIGURE 1 is a sectional side elevational view of the expansion anchor assembly inserted in a bore hole in a mine ceiling whereby turning of the roof bolt will cause expansion of the anchor unit.

FIGURE 2 is a perspective view of the anchor unit prior to use.

FIGURE 3 is a perspective view of the expander plug. FIGURE 4 is a perspective view of the anchor unit and roof bolt after expansion of the shell portion has taken place.

FIGURE 5 is a perspective view of a formed washer and nut for use with a rock bolt.

FIGURE 6 is a perspective view of the anchor unit after the upper end of the roof bolt has been driven through the crown portion of the shell; and

FIGURE 7 is a sectional side elevational view of the expansion anchor of FIGURE 1 and the formed washer and nut of FIGURE 5 in use in a mine ceiling bore.

Referring now in detail to the drawings, an expansion anchor assembly indicated generally by numeral 10 is shown installed in a mine ceiling 12 provided with a drilled hole 14. The anchor unit 10 is adapted to anchor a roof bolt 15 having a head 16 bearing against a plate 18 which is to be drawn into supporting engagement with the mine ceiling 12. Alternatively as shown in FIGURE 7 a headless bolt 15' provided with a nut 17 is used with a concavo-convex formed washer 19 which will be described in detail below.

The anchor unit 10 includes an integral shell 20 and an expander plug 21 which is shown more clearly in FIGURE 3. The shell 20 is preferably cast metal and includes a cup shaped crown portion 23 having an end wall 24 and a depending cylindrical side wall 25 joined to the end wall 24 by a reinforced shoulder portion 26. The end wall 24 is provided with a portion 27 of reduced thickness.

The shell 20 includes three wing portions 30 which are segments of a cylinder and are joined at their normally upper ends 32 to the wall 25 and form extensions of the cylindrical side wall 25 of the crown structure 23. Each of the wing portions 30 tapers upwardly and radially outwardly to provide flat wedging surfaces 33.

It will be noted that the width of each of the segments at its junction with the depending wall is approximately one-sixth of the circumference of the wall 25.

Each of the shell segments or wings has transverse teeth or ribs 35 formed on its periphery. The shell segments also have arcuate recesses 36 formed in their lower inner faces to receive the bolt 15 when the shell 20 is unexpanded (see FIG. 4).

The expander plug 21 may be cast or forged to provide a threaded axial bore 40 and three downwardly and inwardly tapering flat wedging surfaces 41 to cooperate with the flat wedging surfaces 33 of the shell 20. The plug 21 also has a wall portion 42 between adjoining wedging surfaces 41. These wall portions 42 define segments of a cylinder so that when the wedge plug 21 is received be-

tween the upper portions of wings 30, a generally cylindrical exterior is presented by the assembly.

The anchor unit 10 is assembled by spreading the wing portions 30 to permit the expander plug 21 to be inserted therebetween or by merely forcing the plug 21 into the shell 20. It is then desirable to reshape the shell 20 to present a substantially cylindrical exterior. This is done through the use of a die having an aperture of the same diameter as the crown 23 which is forced down over the crown.

It will be apparent that the anchor unit 10 will remain in the assembled condition even though subjected to the extremely rough handling generally encountered in the mine. This ruggedness of the unit 10 is due to the reinforced crown structure 23 and the integral connection of the wing portions 30 thereto.

In use of the anchor unit 10, the bolt 15 is inserted through the plate 18 and the upper end thereof is threaded into the bore 40 of the expander plug 21. The anchor unit 10 and bolt 15 are then inserted in the mine ceiling bore 14. The integral connections of the wing portions 30 and the crown portion 23 are sufficiently resilient to cause the wings 30 to exert some pressure on the walls of the bore 14. Thus the sharp edges of the lower ribs 35 engage the wall to keep the shell 20 from turning in the initial stage of installation.

It will be noted that the bolt 15 is not fully inserted into the bore 14 (as shown in solid lines in FIGS. 1 and 7) as the bolt 15 is preferably capable of being turned to move the wedge plug 21 a distance sufficient to expand the shell 20 the desired amount before tension is developed in the bolt 15 or 15'.

Turning the bolt 15 into the wedge plug 21 causes the upper end of the bolt 15 to engage the underside of the end wall 24 of the shell 20. Continued rotation of the bolt 15 forces the wedge plug 21 axially downwardly toward the open end of the shell 20. This axial movement of the wedge plug 21 causes the wing portions 30 to be spread as shown in FIG. 4, due to the cooperative engagement of the wedging surfaces 33 and 41. It will be appreciated that the ribs 35 will indent themselves to some extent in the wall of the drill hole 14 during expansion of the shell 20.

After the anchor unit 10 has been expanded to a point of secure anchorage as allowed by the resistance of the rock, continued rotation of the bolt 15 causes the plates 18 or 19 to be drawn into engagement with the mine ceiling 12 by the bolt head 16 or nut 17 as shown in broken lines in FIGS. 1 and 7.

If the particular rock bolting technique requires that tension be provided in the bolt, further turning of the bolt 15 is carried out until the desired tension is obtained. The tension in the bolt may be conveniently measured with reference to the torque required to turn the bolt or with reference to the force required to flatten the triangular washer 19 as shown in broken lines in FIG. 7.

Many advantages flow from the particular arrangement of the parts described above. Firstly, the flat wedging surfaces 33 and 41 provide greater load bearing surface area to expand the shell 20.

This is particularly advantageous when the anchor unit 10 is used in soft rock.

Secondly it is possible to provide a shell 20 having an end wall 24 of a particular shape or thickness so that the wedge plug 21 will be subjected to a predetermined axial force prior to failure of the end wall 24 of the shell 20. The force required to expand the shell 20 is thus provided prior to tensioning of the bolt 15 and can be roughly determined with reference to the torque applied to the bolt before failure of the end wall 24 of the shell 20 takes place.

By way of example it was found that approximately 30 to 40 ft. lbs. of torque caused failure of the end wall 24 and in the particular rock formation encountered this provided the desired expansion of the shell 20. The upper

end of the bolt 15 having been securely anchored, a force of approximately 140 to 260 lbs. was applied to develop the required tension in the bolt 15.

Finally the wing portions 30 are maintained in proper alignment by the crown structure 23 although the bolt 15 has been driven through the end wall 24. As illustrated in FIGURE 6, the portion 27 of reduced thickness has thus failed so as to allow the bolt 15 to pass therethrough. The portion 27, however, remains attached to the crown 23 and an outer edge thereof engages the threads of the bolt 15 to prevent relative movement of the shell 20 and wedge plug 21.

Turning now to the formed washer 19 and nut 17 mentioned above in connection with FIGURE 7 and shown in more detail in FIGURE 5, it has been found that such washers are particularly advantageous in certain rock bolting operations. These advantages include the reduction in cost due to a thinner material being used, better seating on irregular rock surfaces, and improved bearing surfaces on the nut and washer or plate. The formed washer 19, by collapsing under a predetermined force, further provides an indication of the load carried by the bolt.

Referring in detail to the drawings, the formed washer 19 shown in FIGURE 5 is a dished substantially triangular plate having integral reinforcing ribs 50 and a centrally located aperture 51. The diameter of the aperture 51 is preferably such that the expansion anchor assembly 10 will pass therethrough. It will be noted that the aperture 51 is counter sunk at 52 on the convex side of the washer to cooperate with nut 17.

The nut 17 has an integral substantially hemispherical portion 55 adapted to seat in the aperture 21 of the washer 19 for limited universal movement relative thereto. A threaded bore 56 extends through the hemispherical portion 55 as well as the remaining portion of the nut 17.

The dimensions of the formed washer 19 are such that the washer will flatten as shown in broken lines in FIGURE 7 when subjected to a predetermined force applied by the bolt 15' and the nut 17.

I claim:

1. In a rock anchor unit, the combination of a one-piece shell shaped and dimensioned to receive a wedge plug therewithin, said shell including side walls comprising segments of a cylinder terminating at their normally upper extremities in a crown structure, said crown structure having a strengthened shoulder portion and an end wall, an elongated bolt extending into said shell, a formed washer comprising a substantially triangular concave convex plate having a centrally located aperture therein, and an internally threaded nut having a hemispherical portion adapted to engage and bear against the convex edge side of said aperture, the concave side of said washer being adapted to engage the mine ceiling and be drawn up thereagainst by said bolt and nut, the washer being adapted to retain its shape until a predetermined tension is provided in said bolt whereupon the washer is flattened.

References Cited

UNITED STATES PATENTS

859,532	7/1907	Swortfiger	85—75
1,121,980	12/1914	Conrad	85—75
2,870,666	1/1959	Dempsey	85—87
2,850,937	9/1958	Ralston	85—62
3,115,056	12/1963	Teepie	85—76
3,169,440	2/1965	Taylor	85—62
3,200,693	8/1965	Dickow	85—75

FOREIGN PATENTS

716,309	8/1965	Canada.
875,238	8/1961	Great Britain.
1,231,772	4/1960	France.

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