

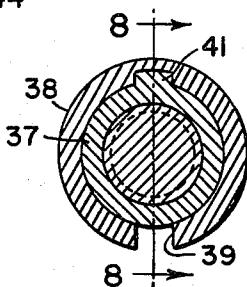
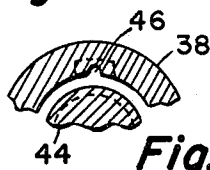
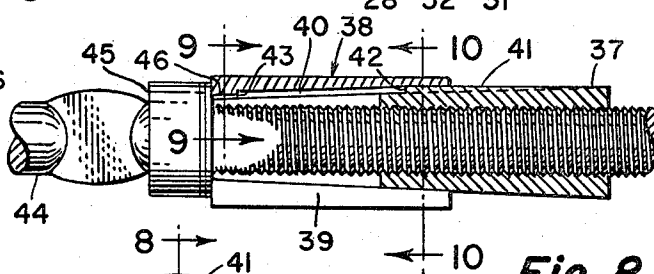
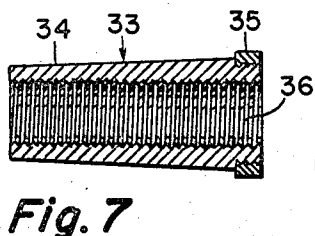
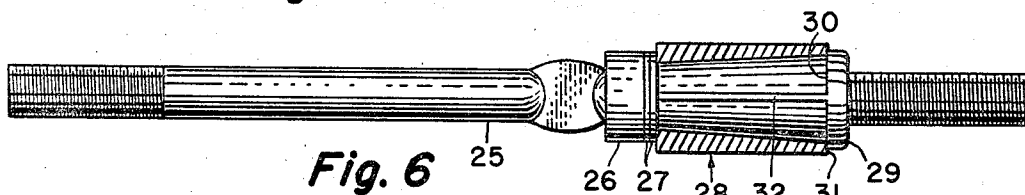
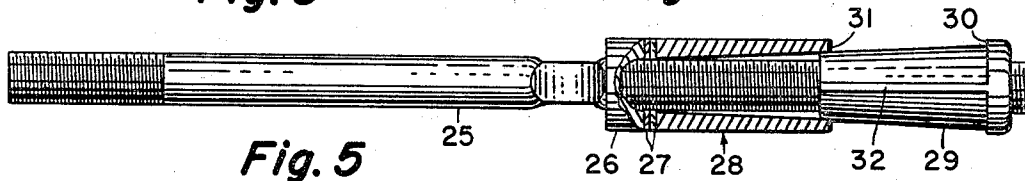
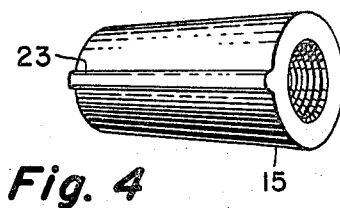
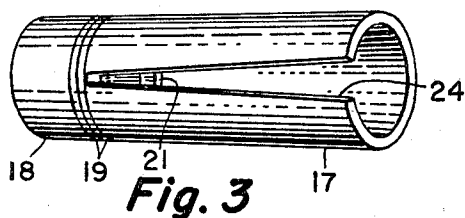
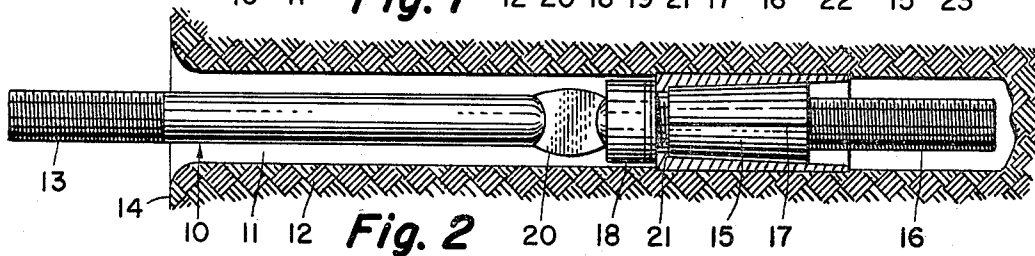
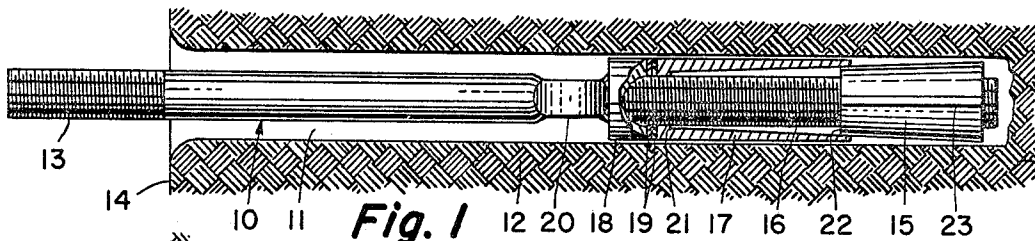
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3,379,089

LIMITED EXPANSION ROCK BOLT ANCHOR

Filed April 4, 1966



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LIMITED EXPANSION ROCK BOLT ANCHOR

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ABSTRACT OF THE DISCLOSURE

A rock anchor with a cone expander surrounded by an expansible shell, in which relative axial movement between the expander and the shell is limited by interengageable abutments on the expander and shell.

This invention relates to the construction of anchoring devices for securing the inner end of a bolt in a hole in rock or concrete. One type of bolt anchor in current use is based upon the action of a cone-shaped nut in threaded engagement with the bolt rod. Rotation of the bolt pulls the cone nut toward the entrance of the hole in the rock, and into an expansible shell surrounding the nut. This wedging action jams the shell outward against the wall of the hole, and produces the anchoring action. Once the anchor has been "set" in this manner, the load on the bolt rod is transmitted through the inclined cone surface to continue the radial pressure.

A problem has been encountered in cases where the rock formation is soft or resilient, or when the bolt is installed in concrete not yet fully cured. In a material such as this, the shell can be forced far enough into the rock—even in a hole initially just large enough to receive the anchor—to permit the expander cone to pull completely through the shell. The present invention provides an improvement in this type of anchor that prevents this pull-out. In summary, interengageable abutments are provided on the cone and shell that limit the relative sliding of the cone and shell to a predetermined amount. Forces are thereafter transmitted from the cone to the shell in an axial direction without further increase in the pressure on the inclined surfaces. Several modifications of the present invention are presented to provide features desirable in particular installations. The several features of the invention will be analyzed in detail through a discussion of the particular embodiments illustrated in the accompanying drawing.

In the drawing:

FIGURE 1 is a sectional elevation showing the installation of a bolt in a hole in concrete or a rock formation, with the anchoring device shown partially in section in the condition as initially installed.

FIGURE 2 is a sectional elevation similar to FIGURE 1, but showing the anchor device in the fully-exposed condition.

FIGURE 3 is a perspective view on a somewhat enlarged scale of the expansible shell and thrust abutment assembly shown in FIGURES 1 and 2.

FIGURE 4 is a perspective view of the cone-shaped expanding nut of the assembly illustrated in FIGURES 1 and 2.

FIGURE 5 is an elevation, partially in section, of a modified form of the invention, in the unexpanded condition.

FIGURE 6 is a view of the mechanism shown in FIGURE 5, in the fully expanded condition.

FIGURE 7 is a sectional elevation showing a modified form of cone construction.

FIGURE 8 is a sectional elevation of a further modification of the invention, in the unexpanded condition.

FIGURE 9 is a section on the plane 9-9 of FIGURE 8.

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FIGURE 10 is a section on the plane 10-10 of FIGURE 8.

Referring to FIGURES 1 and 2, the rock bolt generally indicated at 10 is shown installed in the hole 11 in the rock formation 12. The outer end 13 of the bolt is threaded to receive a nut, and a relatively heavy bearing plate is usually interposed between the nut and the surface 14 of the rock formation. The nut and the bearing plate are conventional, and are not shown in the drawings.

A cone-shaped nut 15 is in threaded engagement with the inner end 16 of the bolt rod, and clockwise rotation of the rod from the surface will produce an axial movement of the nut 15 to the left, as shown in FIGURES 1 and 2. The expansible shell 17 surrounds a portion of the nut, and is wedged to an increased circumscribed diameter as the nut begins its axial movement. The axial thrust on the shell 17 produced by the movement of the cone nut is resisted by the abutment ring 18 and the thrust-transfer washers 19, since relative rotation will normally take place between the thrust ring 18 and the left end of the shell 17. The abutment ring 18 is normally in threaded engagement with the end 16 of the rod, and its axial placement with respect to the rod is assured by the provision of the flattened area 20 which supplements the end of the threading on the rod to prevent further axial movement of the ring 18 as the thrust forces from the nut 15 increase.

To assure that the relative axial movement between the cone 15 and the shell 17 is limited to the position shown in FIGURE 2, an annular shoulder 21 is provided on the inside surface of the shell 17 which is engageable with the left end 22 of the cone when these two members arrive at the FIGURE 2 position. The forces generated at the annular shoulder are in a primarily axial direction, and supplement the axial component of the jamming action generated on the inclined peripheral surface of the cone 15 acting against the similarly-shaped conical inside surface of the shell 17. Because of the well-known "stick-slip" characteristics of friction, it is most likely that the shoulder 21 will not have to sustain a shear stress as large as might appear to be the case. Once the relative sliding movement between the cone and the shell has been completely halted by the presence of the shoulder, the friction characteristics of a completely static nature will develop between the peripheral surface of the cone 15 and the inside surface of the shell 17 to develop further resistance to pull-out.

The initial rotative restraint which permits rotation of the rod from the surface to induce movement of the nut 15 is caused by the drag of the nut and the shell 17 against the wall of the hole 11. To assure that the shell and nut are rotatively fixed with respect to each other, and to further increase the drag against the wall of the rock formation, the ridge 23 is provided on the periphery of the cone 15. This ridge is received within the peripheral discontinuity 24 of the expansible shell 17, with this configuration resulting in a generally C-shaped configuration for the shell. This particular feature is well-known, and forms no part of the present invention.

Referring to FIGURE 5, the bolt 25 may be similar in all respects to the bolt 10 shown in FIGURE 1. The abutment ring 26 and the thrust-transfer washers 27 are also similar, but the shell 28 has a continuous conical interior surface, without the provision of the shoulder 21. In the FIGURE 5 modification, the expansion induced by the cone nut 29 is limited by the engagement of the shoulder 30 on the nut with the end 31 of the shell 28. The ridge 32 is preferably included on this form of nut also, and is received in a discontinuity in the side of the shell 28 as previously described. One advantage of the placement of the abutment on the large end of the cone, rather than

on the relatively small left end of the interior surface of the shell, is that the increased peripheral distance correspondingly increases the potential shear resistance of the material forming the shoulder on the cone over that of the available peripheral length of the material forming the shoulder 21 on the shell. It is also usual practice to form the cone 29 of a somewhat stronger material than that of the shell 28, so the provision of the shoulder on the stronger material is also an advantage. It should be noted that both the arrangements shown in FIGURES 1-2 and that shown in FIGURES 5-6 require a slightly greater diameter in the hole for a given degree of clearance and expansion, assuming the same slope on the peripheral surface of the cone and interior of the shell.

The modification shown in FIGURE 7 illustrates the manner which the same general effect as that provided by the shoulder 30 can result from a two-piece cone construction. The cone 33 has a tapered body portion 34, and a ring 35 in threaded engagement with the large end of the cone. It is preferable that the "hand" of the threaded engagement of the ring with the body 34 be of opposite hand to that of the thread system 36 on the interior of the cone, and which engages the threaded inner end of the bolt rod. This arrangement eliminates the possibility that the rotation of the rod during the setting of the anchor might accidentally back-rotate the ring 35, and loosen it to the point where it cannot perform its function.

The modification shown in FIGURE 8, supplemented by FIGURES 9 and 10, illustrates an arrangement for limiting the penetration of the cone nut 37 into the shell 38 without substantial increase in the circumscribed initial diameter required for a given degree of expansion. The C-shaped shell 38 has the usual discontinuity shown at 39 in FIGURE 10, and also has a recess 40 on the interior surface at the diametrically opposite side. This recess receives the relatively wide projection 41 on the surface of the cone nut 37, and a point is ultimately reached in which the end 42 of this projection collides with the shoulder 43 that defines the left axial end of the recess 40. The expansion of the shell 38 as the bolt rod 44 is rotated with respect to the nut 37 produces axial forces that are resisted by the abutment ring 45 as previously described, and this expansion produces a clam shell-type opening of the shell 38. The presence of the recess 40 produces a desirable point of weakness at a predetermined position, and the shell will rupture along an axial plane that intersects this recess. Since it is desirable to assure that both sides of the shell 38 (on the opposite sides of the rupture plane) are still engaged by the shoulder 42, it is preferable to provide a notch in the position shown at 46 in a generally axial direction along the central area of the portion of the shell 38 that defines the shoulder 43. This will tend to assure that the crack will take place in the middle of the shoulder, and thus leave some portions of the shoulder 43 on both sides of the crack for engagement with the end 42 of the projection 41.

The particular embodiments of the present invention which have been illustrated and discussed herein are for illustrative purposes only and are not to be considered as a limitation upon the scope of the appended claims. In these claims, it is my intent to claim the entire invention disclosed herein, except as I am limited by the prior art.

I claim:

1. In a rock anchor including a threaded rod section,

a generally cone-shaped expander having a major and a minor end, and in threaded engagement with said rod section, a ring normally axially fixed with respect to said rod section, and disposed opposite and initially spaced from the minor end of said expander, and an expansible shell having an interior surface normally bearing on the peripheral surface of said expander, and having an end normally engaging said ring, the improvement comprising:

means on said shell defining an axial discontinuity along one side thereof providing a C-shaped configuration in cross section, said shell having and axially-extending recess in the interior surface thereof diametrically opposite from said discontinuity and terminating at a point spaced from the end of said shell adjacent to said ring, said expander having a peripheral projection received in said recess, the ends of said projection and recess forming abutments limiting relative axial movement between said shell and said expander, said shell also having an axial groove on the interior surface thereof in alignment with the center of said recess to provide a point of stress concentration and localize fracture of said shell so that both of the separating sides thereof will be engaged by the end of said projection.

2. In a rock anchor including a threaded rod section, a generally cone-shaped expander having a major and a minor end, and in threaded engagement with said rod section, a ring normally axially fixed with respect to said rod section, and disposed opposite and initially spaced from the minor end of said expander, an expansible shell having an interior surface normally bearing on the peripheral surface of said expander, and having an end normally engaging said ring, the improvement comprising:

means forming a ring portion on said expander, said ring portion being in threaded engagement with said expander with threading of opposite hand to that of said rod section, said ring portion forming a shoulder adjacent the major end of said expander, and initially spaced from the adjacent end of said shell and engageable therewith to limit relative sliding movement between said shell interior surface and said expander peripheral surface after substantial relative movement along said surfaces has taken place to induce limited expansion of said shell followed by direct axial transfer of forces between said expander and said shell.

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