MINE ROOF BOLT WITH ABUTTING SHOULDER PREVENTING OVER-EXPANSION

INVENTOR
JOSEPH B. DEMPSEY

ATTORNEYS
MINE ROOF BOLT WITH ABUTTING SHOULDER PREVENTING OVER-EXPANSION

Joseph B. Dempsay, Marietta, Ohio, assignor to Pattin Manufacturing Company, Inc., Marietta, Ohio, a corporation of Ohio

Application February 21, 1955, Serial No. 489,696

1. Claim. (Cl. 85—2.4)

This invention relates to nine roof bolts, and more particularly, to improvements in mine roof bolts of the type shown in my copending application, Serial No. 324,949, filed December 9, 1952, and now abandoned. This application is a continuation-in-part of my copending application, Serial No. 464,137, filed October 22, 1954, and now abandoned.

The mine roof bolt assembly disclosed in the first-mentioned above application includes, in general, a multi-part permanent anchoring means mounted on one end of a long headed bolt for retaining engagement with the side walls of the upper portion of a hole drilled in a mine roof. Such anchoring means includes an expansible anchoring shell formed in two separate parts mounted on opposite sides of the bolt and each shaped as a longitudinally tapered segment of a hollow cylinder. The side edges of each part are coplanar to provide inner faces that are opposed to the corresponding side edges or inner faces of the other part with such opposed faces of both parts of the anchoring shell being divergent away from the head of the bolt, i.e. toward the threaded end of the latter. The anchoring means also includes a wedge nut which is threaded onto the bolt between the two shell parts and has diametrically-opposite side faces complementary to and adapted for mutual wedging engagement with the side edges or inner faces of the two shell parts. Hence, relative longitudinal movement between the nut and the shell in one direction will cause expansion of the shell into firm assembly-retaining engagement with the side walls of the hole in the mine roof.

The two parts of the anchoring shell in such assembly, are connected together by a generally U-shaped member having spaced legs interconnected by a base portion. The two spaced legs are secured to the two shell parts adjacent the upper or smaller ends of the latter with the base portion extending across the upper, or larger end, of the wedge nut, so that the upper end of the wedge nut or the threaded end of the bolt will contact the base portion and carry the shell along with the nut and the bolt when the latter is pushed upwardly into a hole in a mine roof for installation of the entire assembly.

In the mine roof bolt shown and disclosed in the first aforementioned application, the U-shaped connecting member is formed from a relatively narrow strip of spring metal. It has been found in actual installation of such an assembly that when during installation the end of the bolt contacts the relatively narrow strip of metal forming the base portion, the latter tends to slip off to one side or the other of the bolt end and thereby cock the two parts of the shell in the hole with a resulting detrimental effect on the shell-expanding wedging action between the wedge nut and the shell parts. Additionally, it has been found in actual practice that in many instances the end of the bolt is not absolutely flat and tends to engage the base portion only at an off-center location to thereby apply an off-center force to the connecting member which results in a relative shifting of the two parts of the shell longitudinally of each other. Again, such shifting detrimentally affects the shell-expanding wedging action between the wedge nut and the shell parts. Also, in some instances considerable force is exerted against such base portion by the bolt end, resulting in distortion and even occasional fracture of the base portion. Such events may also cause relative shifting of the shell parts and impair their wedging action with the nut.

The aforesaid drawbacks can be overcome by shaping the base portion of the connecting member so that it cannot be engaged by the end of the bolt, as by forming such base portion in the shape of a collar having a central aperture large enough to freely receive the threaded end of the bolt. It has been found in actual practice, however, that it is desirable for the bolt end to engage the base portion during the initial stages of the installation of the assembly because rotation of the bolt then produces an initial wedging relative movement between the nut and the shell that expands the shell into non-rotative engagement with the side walls of the hole. Such initial expansive engagement precludes a tendency of the entire anchoring means, including the wedge nut and the shell, to turn in the hole on rotation of the bolt, with a consequent failure of the shell to expand into engagement with the side walls of the hole.

When a mine roof bolt assembly of the aforesaid type is installed in relatively soft mine roof strata, it is possible to expand the shell indefinitely without exerting undue force. Power tools usually are used to rotate the bolt for installation of such assemblies, and in soft roof strata where resistance to turning movement of the bolt does not build up rapidly on expansion of the shell, an operator frequently will continue to operate a power tool until the wedge nut is pulled completely through the anchoring shell. Of course, in such an event, the bolt and nut will fall from the hole with resulting danger to the operator and possible damage to mining equipment.

Accordingly, it is an object of this invention to provide an improved mine roof bolt assembly of the type under consideration with means for assuring that the multi-part expansible anchoring means will not initially turn in the hole so that positive expansion will be had and also with improved means for connecting the shell parts together so that they cannot be shifted out of their proper relationship to the wedge nut.

It is another object of this invention to provide a mine roof bolt assembly of the type under consideration with means for assuring that the wedge nut cannot be pulled completely through the anchoring shell and permit the bolt and the wedge nut to fall from the hole.

It is a further object of this invention to provide a simple and economically manufactured mine roof bolt assembly which will accomplish the foregoing objects.

Other objects and advantages of the invention will be apparent from the following description and accompanying drawings, in which:

Figure 1 is a fragmentary, vertical sectional view through a drilled hole in a mine roof showing the initial step in the installation therein of a mine roof bolt assembly embodying this invention;

Figure 2 is a view corresponding to Figure 1 but showing the initial wedging engagement between the wedge nut and the anchoring shell so that the latter is initially expanded into retaining engagement with the side walls of the hole;

Figure 3 is a view corresponding to Figure 1 but showing the completed installation of another embodiment of mine roof bolt assembly embodying this invention;

Figure 4 is a fragmentary side elevational view of the mine roof bolt assembly shown in Figure 2;

Figure 5 is a fragmentary vertical sectional view of the
assembly shown in Figure 3, but showing the expansive parts in their contracted condition; Figure 6 is a perspective view of the shell connecting member shown in Figures 1, 2 and 4; and Figure 7 is a perspective view of a modified form of shell connecting member.

Figure 8 is a perspective view of another modified form of shell connecting member.

Referring now to the drawings, there is shown in Figures 1, 2, and 3 a mine roof bolt assembly embodying this invention. The assembly includes a relatively long bolt 10, which in some instances may be as long as 96 inches, a generally cylindrical wedge nut 12 threaded onto the upper end of the bolt, and a generally cylindrical expansible anchoring shell 14 arranged to be expanded by axial movement of the nut as the bolt is turned. The bolt 10 includes a smooth shank 16 and a lower head 18 against which a relatively large washer plate 20 is seated for bearing engagement with a mine roof 22 about a hole 24 drilled vertically thereinto and having a diameter only slightly larger than that of the shell 14 when the latter is fully contracted. The nut 12 has an upper annular portion 26 (Figure 5) provided with a pair of downwardly tapered segments 28 depending from opposite sides thereof. Diametrically opposite sides of the annular portion 26 and the opposite edges of the extensions 28 are provided with flat upwardly diverging wedging surfaces 30 which, in the embodiments shown in Figures 1, 2 and 4, have a stepped formation to provide downwardly facing stop shoulders 32 between the ends of such surfaces for purposes later described.

The expansible anchoring shell 14 which cooperates with the nut 12 is of less length than the latter and includes a pair of diametrically opposite parts 34 each shaped as a longitudinally-upwardly tapered segment of a cone of the same outer radius as that of the nut 12 and of an inner radius to loosely fit about the bolt 10. The parts 34 have flat wedging side edges or inner surfaces 36 complementary to but of less length than the corresponding diverging wedging surfaces 30 of the nut 12. The side edges 36 of the shell parts 34 are notched and have a stepped formation to provide upwardly facing stop shoulders 38, so that when the shell 14 is in its contracted condition, such shoulders are spaced longitudinally, or vertically, from the opposed shoulders 32 on the nut 12, as shown best in Figure 2. Preferably, the outer curved surface of each part 34 is provided with a plurality of vertical and circumferential serrations 40, and with a relatively sharp lower edge 42, as disclosed and for purposes described in the first aforementioned application.

The assembly also includes an inverted generally U-shaped connecting member 44, preferably of spring metals having spaced legs 46 interconnected by a base portion 48 which extends across the upper ends of the bolt 10 and the nut 12. The lower or free ends of the legs 46 are fixedly connected to the upper ends of the shell parts 34 by any suitable means, such as by being riveted into appropriate recesses, as at 50, and having deformable shoulders 52 on the recess side edges best thereover, as shown in Figure 4, or the equivalent. The base portion 48 of the connecting member 44 has a collar-like shape adapted for engagement with the annular upper end of the nut 12 and also has a central aperture 54 (Figures 5 and 6) of somewhat larger diameter than that of the threaded end of the bolt 10 for free passage of the latter through such aperture. The aperture is initially closed, in the embodiment shown in Figures 1 to 6, by a knock-out disc or plug 56 which is connected to one side, or two diametrically opposite sides, of the aperture 54 by weakened bridge portions 58. Preferably the adjoining bridge portions are similarly spaced 90° from the legs 46 of the connecting member, i.e., the weakened bridge portions are located in an axial plane disposed 90° from an axial plane which includes such legs. By so locating the bridge portions 58, 59, when one portion 58 yields, as later described, there will be no off-center force exerted on the base portion 48 by engagement of the end of the bolt 10.

For installation of a mine roof bolt assembly embodying this invention, the washer plate 20 is initially slipped over the threaded end of the bolt 10 and then the latter is threaded into the lower end of the wedge nut 12, having the shell 14 preassembled thereon, preferably until the upper end of the bolt is only about half way through the nut. Thereupon, the two shell parts 34 are sprung apart at their lower ends so that the lower maximum diameter of the shell 14 is somewhat greater than the diameter of the hole 24. Whereupon, the bolt 10 together with the nut 12 and shell 14 is pushed upwardly into the drilled hole 24 in the mine roof preferably until the washer plate 20 engages the roof 22, as shown in Figure 1. Such insertion carries the two shell parts 34 upwardly into the hole 24 and engages the upper end of the nut 12 with the base portion 48 of the connecting member 44. It also will be seen that during such insertion the lower sharp edges 42 of the two shell parts 34 spring outwardly and drag against the side walls of the hole 24 to temporarily retain the entire assembly therein, particularly when the hole is oversize.

After the bolt 10 has been inserted into the hole 24 until the washer plate 20 engages the mine roof 22, the bolt is released, for the engagement of a power tool (now shown) with its head 18, and it will be seen that the wedge nut 12, and the bolt 10 and washer 20, will thereupon drop down somewhat before the outer wedging surfaces 30 of the nut engage the corresponding inner wedging surfaces 36 of the two shell parts. Because of the heavy weight of the bolt 10, there will also be some movement of the lower apex edges 38 of the shell parts 34 before the lower sharp edges 42 of the shell parts 34 dig into the side walls of the hole 24 sufficiently to hold the weight of the assembly. Thereupon, the bolt is rotated and it will be seen that the initial effect of such rotation will be to cause the entire bolt 10 and washer 20 to rise until the upper end of the bolt contacts the knockout plug 56. Continued rotation of the bolt 10 then tends to pull the two shell parts 34 upwardly by the connecting member 44, to move the nut 12 downwardly because of the reaction force of the connecting member against the bolt, and effect a wedging action by the nut 12 because the initial resistance to such pull or force is less than the initial torque resistance of the shell 14 occasioned by its engagement with the side walls of the hole 24. Hence, a shell-expanding wedging action between the nut 12 and the shell 14 is initially started which causes the latter to bite into firmer engagement with the side walls of the hole 24 and further increase the torque resistance of the shell. Further rotation of the bolt 10 exerts a strong upward force against the disc 56, by the engagement of the upper end of the bolt therewith, and consequently against the base portion 48 of the connecting member 44. Such a force cannot become excessive, however, because one or both of the bridges 58 will yield, as shown in Figure 2, enabling the knock-out plug 56 to be pushed out of the aperture 54 and the bolt 10 to pass freely therethrough to thus seat the washer 20 against the mine roof.

Hence, during installation of the assembly excessive forces cannot cause the bolt 10 to slip off of the base 48 of the connecting member 44 to one side or the other and thus result in a cocking of the two shell parts 34 in the hole 24. Also, the bolt 10 cannot exert excessive forces adjacent one end only of the base 48 of the connecting member 44 and thereby possibly result in a longitudinal or vertical relative shifting of the two shell parts 34. Hence, continued rotation of the bolt 10 draws the wedge nut 12 downwardly and forcefully expands the shell 14 into firm engage-
ment with the side walls of the hole 24 as shown in the modified embodiment of Figure 3.

In Figures 2 through 4 when the shell 14 is pushed into the hole 24, the legs 32 and 38 on the nut 12 and the shell parts 34 are engaged. At this time, further turning of the bolt 10, even by a power tool, becomes substantially impossible and the mine roof bolt is finally installed under tension in the hole 24 in the mine roof. To resist bolt loosening installed in relatively hard mine roof strata, a power tool used for the installation probably will stall before the stop shoulders 32 and 38 on the nut 12 and on the shell 14 are engaged.

In the above described embodiment, it will be seen that the collar-like base portion 48 of the connecting member 44, together with the knock-out plug 56, covers the annular joint between the engaged threads on the bolt 10 and the nut 12 during the step of inserting the assembly. Such coverage greatly inhibits the possibility of dirt getting between such threads and possibly fouling and damaging the same to a condition of ineffectiveness.

Many of the same results of the foregoing embodiment can also be obtained by modified form of connecting member 60 shown in Figure 7 wherein the base portion 62 is of collar-like form formed with a central bolt-receiving aperture 64 as before. In this embodiment, however, instead of a knock-out plug 56, there are provided one or two diametrically opposite bendable tabs 66 projecting radially inwardly from the central aperture 64 and located in substantially the same positions with respect to the nut 68 as the above described weakened bridge portions 58.

It will be seen that during the initial installation of a mine roof bolt embodying this modified construction, the bendable tabs 66 will be engaged by the upper threaded end of the bolt 10, and upon rotation of the latter will cause a desirable initial wedging action between the nut 12 and the shell 14, as before described. An increasing force against the tabs 66, however, will cause them to yield and allow the end of the bolt 10 to pass through the central aperture 64 in the base portion 62 of the connecting member 60 to thereby completely avoid any undesirable cocking or relative vertical shifting of the shell parts in the hole.

In the embodiment of Figures 3 and 5, there is disclosed another means for preventing the nut 12 from being pulled completely through the shell 14. In this embodiment, the wedging surfaces 36 and 30 of the shell 14 and the nut 12 are unimpacted throughout their entire lengths, so that the stop shoulders 32 and 38 are eliminated. The thread 70 on the bolt 10 is, however, of limited extent, and since such thread preferably, and for reasons of economy, is rolled onto the bolt, the smooth shank 16 of the bolt is of substantially the same diameter as the root diameter of such thread. At the lower end of such thread there is also formed on the bolt an annular ridge 72 of greater diameter than the crest diameter of the thread 70 to serve as a stop for the nut 12. The length of the bolt thread 70 is proportioned so that when the wedge nut 12 is pulled down to effect a predetermined maximum expansion of the shell 14, less than the expansion effected by pulling the wedge nut almost through the shell, the lower end of the wedge nut engages the ridge 72 on the bolt 10 and prevents further relative longitudinal movement between the nut and the bolt. Consequently, the stop ridge 72 on the bolt 10 prevents pulling the wedge nut 12 completely through the shell 14.

Although the shell connecting members shown in Figures 6 and 7 are preferred, with that shown in Figure 6 being particularly preferred, the connecting member 74 shown in Figure 8 also provides the advantageous result of preventing cocking of a shell 14 in a hole or relative shifting of its parts 34 out of proper wedging relationship with a nut 12. In this modification, the member 74 has a collar-like base portion 76 provided with a completely unobstructed central grinding aperture 78 which precludes forceful engagement of the base portion 76 by a bolt 10. In use of such a connecting member 74, an initial wedging action between a nut and shell is not occasioned by the reaction of a bolt against the member 74, but such an action is not always essential, as where the entire assembly has a drive fit in a hole. It thus will be seen that the objects of this invention have been fully and effectively accomplished. It will be realized, however, that various changes may be made in the specific embodiments disclosed to illustrate the principles of this invention without departing from such principles. Therefore, this invention includes all modifications which are encompassed within the spirit and scope of the following claim:

I claim:

A mine roof bolt assembly comprising an expandable anchoring shell having two separate diametrically-disposed parts, each shaped as a longitudinally-tapering segment of a hollow cylinder and having stepped longitudinal side edges each disposed in two parallel planes and defining a shoulder therebetween, each stepped side edge extending the entire length of the corresponding part, and each opposed to the corresponding part edge of the other part, each corresponding pair of said opposed edges being divergent toward one end of said shell to form a stepped V-shaped slot between said parts with said shoulders facing toward said one end; and having planar surfaces complementary thereto and in mutual wedging engagement therewith for effecting expansion of said shell upon relative longitudinal movement between the latter and said wedge means in one direction, said surfaces of said wedge means being of greater length than said shell part side edges and in wedging engagement with at least both end portions of the latter throughout said relative movement from substantially fully contracted to substantially maximum extended condition of said shell, the stepped planar surfaces of said wedging means defining shoulders facing in the opposite direction from the shoulders on said parts being at least as small as that of said shell when the latter is in said fully contracted condition; and a U-shaped resilient member having the legs thereof secured to said shell parts and the base thereof extending diametrically of said shell at said one end thereof over one end of said wedge means.

References Cited in the file of this patent

UNITED STATES PATENTS

Re. 22,354
Kolm .................. July 27, 1943
13,177
Loudon et al. ............... July 3, 1855
406,565
Church .................. July 9, 1889
724,216
Steward .................. Mar. 31, 1910
1,139,712
Osborne .................. May 18, 1915
1,552,494
Zifferer .................. Sept. 14, 1920
1,549,326
Pleister .................. Aug. 11, 1925
1,549,327
Pleister .................. Aug. 11, 1925
2,667,099
Lewis ..................... Jan. 26, 1954
2,753,750
Demouyse ................. July 10, 1956

FOREIGN PATENTS

767,444
France .................. July 17, 1934
1,018,678
France .................. Oct. 15, 1952