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2,952,129

**MINE ROOF BOLT INSTALLATION**

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Filed Jan. 9, 1958, Ser. No. 707,988

6 Claims. (Cl. 61-45)

This invention relates to mine roof bolt installations and more particularly to improvements in such installations for effectively retaining a grouting material therein prior to its hardening. This application constitutes a continuation-in-part of my copending application Serial No. 398,826, filed December 17, 1953, issued April 8, 1958, as Patent No. 2,829,502.

Mine roof bolts, and their usages, are known in the art and usually comprise a headed bolt of from about three to about five feet long and an expansible anchoring means threadedly engaged therewith. In use, a mine roof bolt is inserted in a drilled hole in a mine roof, with the anchoring means at the inner end of the hole and a large washer seated against the head of the bolt and abutting against the ceiling of the mine. Thereupon, the anchoring means is actuated to expand into tight gripping engagement with the side walls of the hole, and the bolt is placed under tension between the washer and the anchoring means. The installation of mine roof bolts in this manner in a plurality of holes in a mine roof serves to lock the roof strata together to prevent falling. Thus, mine roof bolts eliminate the timber shoring previously used to support the roofs of passageways and rooms in a mine.

In some instances, however, mine roof strata is somewhat soft and on exposure to air eventually will slough off, crumble, or spall, thus permitting a mine roof bolt to fall out of the hole by failure of the formation about the bolt anchoring means. In this type of roof strata, mine roof bolts heretofore have provided only a temporary support for the roof, the effectiveness of which decreased with passage of time. Accordingly, in the aforesaid type of mine roof formation, mine roof bolt installations which are not cemented in or grouted can be used only where the passageway or room is not a permanent part of the mine labyrinth. Even so, however, the installation of mine roof bolts not cemented in or grouted is undesirable in strata which tends to eventually crumble or spall because of exposure to air. Because of its weight, a falling mine roof bolt can be quite dangerous to human life. Additionally, the gradual lessening of the supporting effectiveness of a mine roof bolt tends to create a somewhat dangerous situation.

In the aforesaid copending application, there is disclosed a grouted or cemented mine roof bolt installation which includes a capsule, containing a suitable grouting material, insertable into the mine roof hole together with and ahead of the mine roof bolt assembly. After insertion of the bolt assembly and capsule is completed, the latter is opened, as by rupture against the end of the mine roof hole, and the grouting material therein is allowed to flow by gravity within the space in the hole occupied by the bolt assembly. The bolt of the assembly has a washer mounted thereon below the expansible anchoring means on the upper end thereof, which washer engages the wall of the hole so as to confine the grouting material within the space in the hole adjacent the anchoring means until hardened. While a simple flexible disk-shaped

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washer of the type disclosed in the aforesaid application is satisfactory for most installations, leakage of the grouting material past the washer is not positively prevented, particularly in installations where the wall of the hole is relatively unstable.

Accordingly, it is an object of the present invention to provide a mine roof bolt installation having improved means for retaining a grouting material therein prior to its hardening which overcomes the disadvantages noted above.

Another object of the present invention is the provision of a grouting material retaining means of the type described which is activated into positive sealing engagement with the wall of the mine roof hole in response to the expansion of the anchoring means of the mine roof bolt assembly.

Still another object of the present invention is the provision of a mine roof bolt assembly having improved means for sealing the mine roof hole to retain grouting material therein prior to its hardening, which means is simple but effective in operation and economical to manufacture.

These and other objects of the present invention will become more apparent during the course of the following detailed description and appended claims.

The invention may best be understood with reference to the accompanying drawings wherein an illustrative embodiment is shown.

In the drawings:  
Figure 1 is a vertical sectional view of a mine roof hole showing therein, in elevation, an installation embodying the principles of the present invention;

Figure 2 is a fragmentary cross-sectional view taken along the line 2-2 of Figure 1 showing the sealing means in compressed engagement with the mine roof hole;

Figure 3 is a cross-sectional view taken along the line 3-3 of Figure 1;

Figure 4 is an elevational view, partly in section of the resin container; and

Figure 5 is an elevational view, partly in section of the catalyst container.

Referring now to Figure 1 of the drawings, there is shown therein a hole 10 which has been drilled upwardly from the ceiling 12 of a mine room or passageway into the roof strata 14 thereabove. Positioned in the hole 10 is a mine roof bolt assembly including a bolt 16 and an anchoring means 18 of a type disclosed in Dempsey Patent No. 2,753,750 issued July 10, 1956, and to which reference is made for a more detailed description of the anchoring means. The anchoring means 18, which normally is cylindrical and of a diameter slightly less than that of the hole 10, includes a two-part expansible anchoring shell 20 and a wedge-shaped nut 22 for expanding the shell.

The shell 20, which normally is generally circular in transverse section and of a diameter only slightly less than that of the drilled hole 10, has two diametrically-opposed parts 24, each part being formed as a longitudinal-tapering segment of a cylinder. The tapering longitudinal plane edges 26 of each part 24 are disposed in a common plane with the edge planes of both parts being upwardly divergent. The smaller and upper ends of the two parts 24 forming the shell 20 are connected together by a spring-steel band-like connecting member 28 that is substantially U-shaped. The connecting member 28 has legs 30 which normally are generally parallel and extend generally longitudinally of the shell 20 and a base 32 which extends transversely of the shell somewhat above the upper ends of the two shell parts 24. The two legs 30 of the connecting member 28 may be secured to the shell parts 24 in any appropriate manner, but, as shown, fit into recesses 34 therein and are connected thereto by

pins 36 integral with the parts 24, the pins being peened to retain the legs 30 thereon. The curved outer surfaces of the shell parts 24 preferably are provided with a plurality of step-like circumferential serrations 38 and vertical serrations (not shown) for embedding and gripping engagement with the side walls of the hole 10, as later explained. Preferably, the bottom edge 40 of each shell part 24 is sharp, for a reason that will become apparent later.

The nut 22 is disposed between the two parts 24 of the shell 20 and has opposite plane wedging surfaces 42 complementary to, and in mutually-wedging engagement with, each pair of opposed side plane edges 26 of the shell parts. Preferably, the wedging surfaces 42 on the nut 22 are longer than the longitudinal side edges 26 of the shell parts 24 and extend above the two shell parts, so that when the shell 20 is expanded by downward movement of the nut 22 relative thereto, as later explained, the entire length of the wedging surfaces or plane edges 26 of the two shell parts is engaged with the wedging surfaces on the nut. The exterior surfaces of the nut 22, between its wedging surfaces 42, are arcuate in transverse section to correspond to the circular peripheral outline of the shell 20. At its larger end, the nut 22 is provided with diametric longitudinal channels or grooves 44 to accommodate the legs 30 of the connecting member 28.

The shank 46 of the bolt 16 is threaded into the nut 22, from the lower end thereof, and the lower or outer end of the bolt has an enlarged head 48 having a washer supporting flange 50 of greater diameter than the diameter of the shell and nut assembly or anchoring means 18 when the latter is unexpanded, and a non-circular wrench-engageable portion 52. Seated on the flange 50 of the bolt head 48 is a large washer 54 for engagement with the ceiling 12 about the hole 10. The inner diameter of the washer 54 preferably is slightly larger than the diameter of the anchoring means 18 when the latter is unexpanded, so that the washer can pass thereover into engagement with the flange 50 on the bolt head 48 without disassembly of the bolt 16 from the nut 22.

In use, the mine roof bolt assembly, with the washer 54 in place thereon, is inserted upwardly into the drilled hole 10 until the washer engages the ceiling 12. In so doing, the upper end of the nut 22 will abut against the underside of the base 32 of the member 28, connecting the shell parts 24, to carry the latter along with the bolt and nut as the assembly is pushed upwardly into the hole 10. Prior to such insertion, the two shell parts 24 are sprung somewhat apart, so that as the assembly is pushed upwardly into the hole 10, the sharp bottom edges 40 of the shell parts drag against and engage the sides of the hole and retain the assembly therewithin after insertion therinto. After the assembly has been thus inserted to its full length, the bolt 16 is pulled down somewhat, to thus force the wedging surfaces 42 of the nut 22 into expanding wedging engagement with the shell parts 24 to force the latter oppositely apart into gripping engagement with the side walls of the hole 10. The bolt 16 is then rotated, as by an appropriate power tool (not shown) applied to the non-circular portion 52 of the bolt head 48, to thereby draw the washer 54 upwardly into engagement with the ceiling 12 and thereafter draw the nut 22 downwardly into greater wedging engagement with the two shell parts 24 and force the latter in opposite directions into firmer gripping engagement with the side walls of the hole.

The foregoing steps are the conventional method of installing a mine roof bolt of the type shown in the aforementioned patent. It will readily be seen, however, that the side walls of the hole 10 about the anchoring means 18 are exposed to air, and in the event that the roof strata 14 is of the type that will eventually crumble or spall upon such air exposure, such crumbling or spalling about the anchoring means will eventually relieve its

grip upon the side walls of the hole and permit the entire roof bolt assembly to fall out of the same.

In order to obviate the foregoing difficulty, an installation in accordance with this invention seals off the strata 14 engaged by and immediately above and below the anchoring means 18 from access to air. An installation embodying this invention also excludes air from the hole once the assembly is installed therein. Hence, a mine roof bolt installation embodying this invention is substantially permanent.

In order to provide a substantially permanent installation, a flowable plastic or liquid settable or hardenable cementitious material is applied and confined around and about the nut 22 and the expansible shell 20 when the anchoring means is in place in the hole 10. Preferably, the material is insoluble in water because mine roof strata frequently is damp. Materials suitable for this purpose may include cement grout, a water-insoluble glue, and synthetic resins. Synthetic resins which are activated by the addition of a suitable catalyst are particularly suited to the present purpose because of the ease with which they can be handled.

For example, there can be used as the grouting material the product made by mixing a spray-dried melamine-formaldehyde condensation product, e.g., as made in example 1 of Widmer Patent No. 2,318,121 with an aqueous solution of an acid catalyst such as oxalic acid or ammonium sulfate. Thus, 100 parts of the resin can be mixed with a solution of 1 part of oxalic acid in 60 parts of water or 5 parts of ammonium sulfate in 45 parts of water.

An alternative grouting material can be prepared by mixing an epoxy resin such as those shown in Bradley Patent 2,500,600 with an amine curing agent. In a specific example 100 parts of Epon 828 (a liquid bisphenol A-epichlorhydrin resin) and 10 parts of diethylene triamine as a curing agent were mixed to form the grouting compositions.

Other resins which can be employed are phenol-formaldehyde, phenol-furfural, furfuryl alcohol, urea-formaldehyde and polyester resins, e.g., polyethylene maleate-adipate modified with styrene.

A preferred arrangement for handling such resins is shown in Figures 1, 4 and 5. The resin itself is placed in a first container or capsule 56, shown in Figure 4, which container has sufficient capacity to hold the desired quantity of resin and to receive the catalyst so that the latter can be mixed therewith prior to insertion within the mine roof hole. The catalyst can be separately retained in the container 56, as by a rupturable capsule or compartment disposed therein, however, as shown in Figure 5, the catalyst is contained within a separate container 58.

Prior to installation, the containers 56 and 58 are sealed by suitable closures 60 and 62, respectively. When it is desired to utilize the installation, the closures 60 and 62 are removed and the catalyst in the container 58 is poured in with the resin in the container 56 and stirred or otherwise thoroughly mixed therewith as, for example, by replacing the closure 60 and shaking, provided the mixture is sufficiently viscous to permit such action. The container 56 with the mixture therein is then inserted in the hole 10 and moved upwardly therein by the insertion of the mine roof bolt assembly therein in its normal way. The closure 60 may be replaced on the container 56 prior to its insertion in the hole, although this is not necessary, and therefore, in order to save time, it is preferable to insert the container in the hole with its upper end open.

The container 56 is opened to permit the mixture therein to flow by gravity within the hole 10 around the bolt assembly therein by engagement with the strata defining the upper end of the hole 10. To this end, the container is preferably made of a rupturable or fracturable material such as glass, plastic or the like.

The present invention is more particularly concerned

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with a novel sealing means, generally indicated at 64, which is operable to engage the wall of the hole adjacent and below the expansible shell 20 to retain the resin mixture in the hole thereabove in surrounding relation to the nut 22 and expansible shell. The sealing means 64 comprises a rigid disk or washer 66 which is slidably mounted on the upper end of the bolt 16 and secured thereon against downward movement beyond a position spaced just below the shell 20 by projections 68 or the like formed on the bolt by interrupting the exterior surface thereof with a press or the like. Mounted on the bolt above the washer 66 is a gasket or flexible washer 70 which is preferably made of foamed natural rubber, synthetic rubber or plastic. Preferably, the gasket 70 is made of a closed cell sponge construction so that in its normal condition it will effectively prevent the passage of a fairly thick liquid. The gasket is also desirably of a relatively great thickness, as, for example, three quarters of an inch, so as to provide adequate radial movement upon compression. If desired, an upper rigid disk or washer 72 is slidably mounted on the bolt above the gasket or flexible washer 70.

#### Operation

As indicated above, the open container 56 having the mixed resin and catalyst therein is inserted into the hole 10 ahead of and by the insertion of the roof bolt assembly therein, as shown in Figure 1. In most installations, this insertion is performed by the power tool used to turn the bolt head to expand the anchoring assembly. The hole 10 has been previously drilled to a predetermined height in the mine roof so that the strata defining the upper end thereof will be engaged by the container during the upward inserting movement, and thus fractured just prior to or simultaneously with the assembly reaching its fully inserted position within the hole.

When the assembly is fully inserted, the operator actuates the power tool to turn the bolt head and effect expansion of the anchoring assembly. During this expansion it will be noted that the nut 22 moves downwardly on the bolt 16. The flexible washer 70 is retained on the bolt against downward movement by the lower rigid washer 66 in a position to be engaged by the lower end of the nut 22 during its downward movement. Where the upper rigid washer 72 is not utilized, the flexible washer 70 is directly engaged by the lower end of the nut and thus expanded into sealing engagement with the adjacent strata 14 defining the hole and the adjacent exterior of the bolt. Where the upper rigid washer 72 is utilized, the lower end of the nut engages the same which in turn serves to evenly compress the flexible washer radially into sealing engagement with the adjacent hole defining strata and exterior bolt surface, as shown in Figure 2.

The compressed engagement of the flexible washer 70 thus caused by the expansion of the anchoring means of the roof bolt assembly serves to positively seal the grouting material flowing by gravity from the opened or fractured container into the space in the hole 10 thereabove and hence around the shell 20 and nut 22. The expansion

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of the anchoring means and the compression of the gasket or flexible washer 70 in response thereto is readily accomplished before the grouting material has time to reach the gasket during its flow from the fractured container.

It will thus 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 method and apparatus shown and described for the purpose of illustrating the principles of this invention without departure from such principles. Accordingly, this invention includes all modifications of apparatus and method encompassed within the spirit and scope of the following claims.

I claim:

1. A mine roof bolt assembly comprising an elongated bolt, expansible anchoring means on one end of said bolt insertable therewith upwardly into a mine roof hole, said anchoring means including portions movable longitudinally with respect to said bolt for effecting expansion of said anchoring means, and radially expansible sealing means disposed adjacent said anchoring means and engageably associated with said anchoring means for radial expansion into engagement with the hole at a position above the lower end thereof in response to at least a portion of the relative longitudinal movement between said bolt and anchoring means portions to effect expansion of said anchoring means.

2. A mine roof bolt assembly comprising an elongated bolt having a wedge member threaded on one end thereof, expansible anchoring shell means on said wedge member operable to expand in response to longitudinal movement of said wedge member with respect thereto as a result of turning said bolt, and radially expansible sealing means carried by said bolt in a position to be engaged by said wedge member during its longitudinal movement with respect to said anchoring shell means to thereby radially expand said sealing means.

3. A mine roof bolt assembly as defined in claim 2 wherein said sealing means comprises an annular washer of resilient material.

4. A mine roof bolt assembly as defined in claim 3 wherein said washer resilient material is foamed.

5. A mine roof bolt assembly as defined in claim 3 wherein said sealing means further includes a rigid disk disposed in engagement with the surface of said washer remote from said anchoring means, and means mounting said disk on said bolt against longitudinal movement in a direction away from said anchoring means.

6. A mine roof bolt assembly as defined in claim 5 wherein said mounting means comprises ears formed in said bolt engaging said disk.

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