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E. F. HUSTON
EXPANSION BOLT WITH COIL SPRING HAVING
OVERLAPPING CONVOLUTIONS AND
OUTWARDLY EXTENDING EDGE

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2 Sheets-Sheet 1

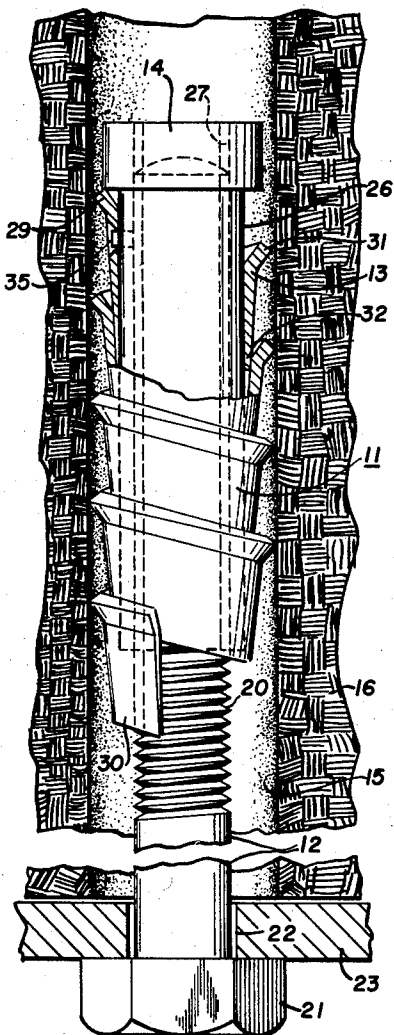


Fig. 1

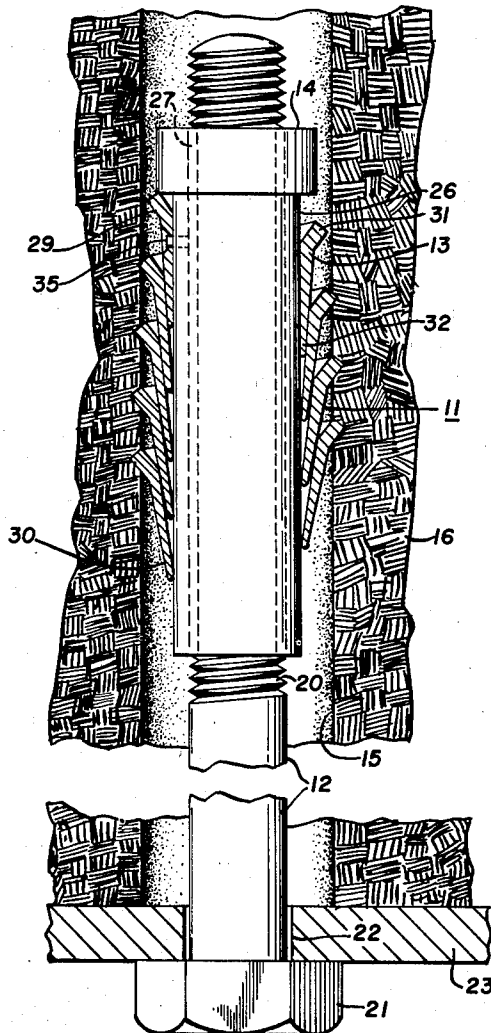


Fig. 2

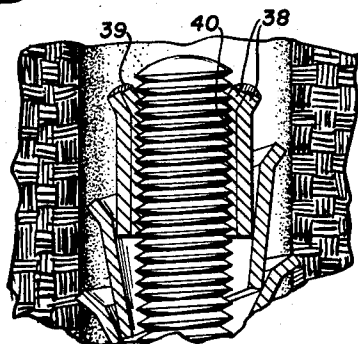


Fig. 3

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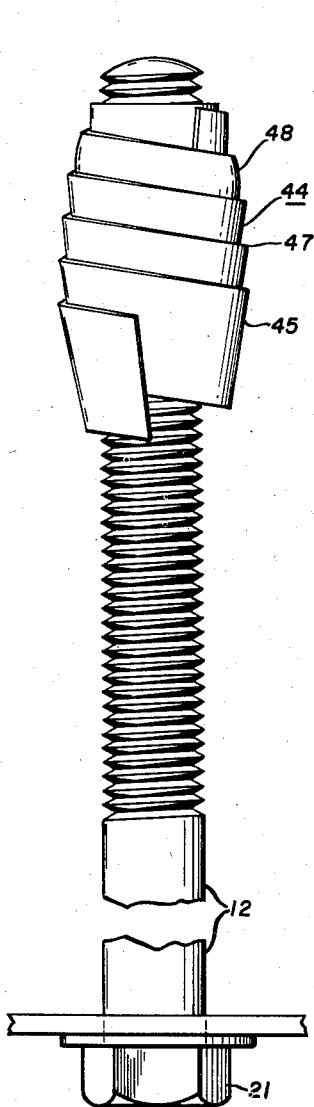


Fig. 4

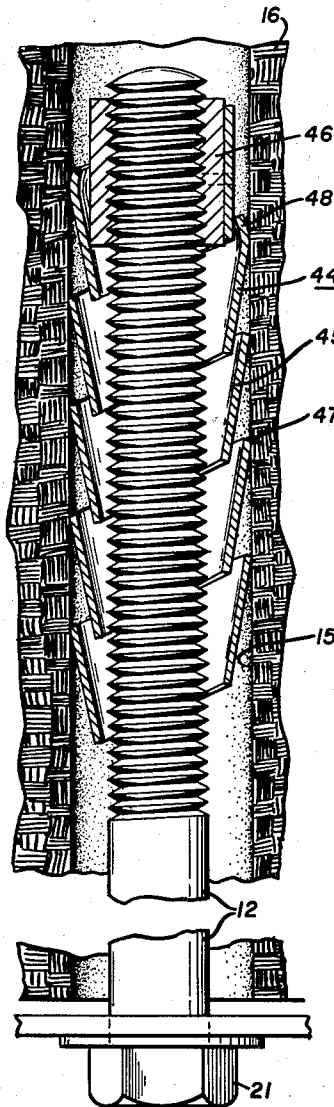


Fig. 5

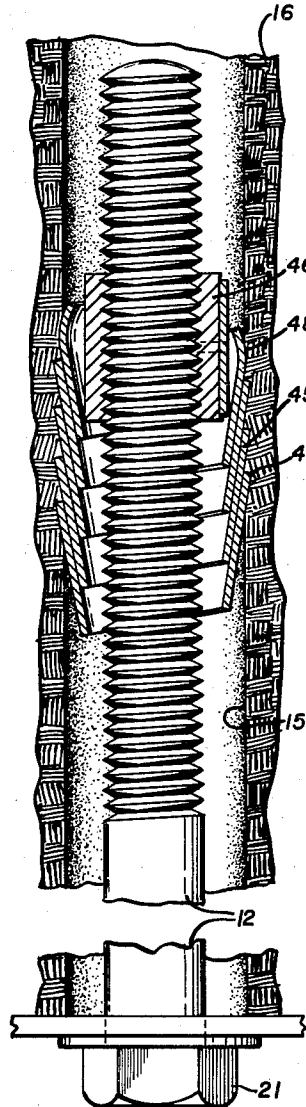


Fig. 6

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EXPANSION BOLT WITH COIL SPRING HAVING OVERLAPPING CONVOLUTIONS AND OUTWARDLY EXTENDING EDGE

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3 Claims. (Cl. 85-2.4)

The invention relates in general to devices frequently termed expansion bolts and more particularly to an anchor expansion device which may be used with threaded bolts particularly to bind together the strata in the roof of a mine by having the expansion bolt inserted and tightened into a hole in the roof of the mine.

Expansion bolts in recent years have largely supplanted the former use of wooden beams to support the roof of a mine. A hole of suitable diameter, for example, one and three-eighths inches, is bored vertically into the roof of the mine to a suitable depth, for example, eighteen to seventy-two inches. An expansion bolt is inserted in this hole and tightened therein. This has the effect of clamping together the various strata in the roof of the mine to prevent collapse of the roof. The present invention relates to an improvement in such expansion bolts or expansion anchor devices used with threaded rods or bolts.

An object of the invention is to provide an expansion bolt which utilizes a minimum of parts and thus is simple to manufacture and operate.

Another object of the invention is to provide an expansion bolt which is reusable.

Still another object of the invention is to provide an expansion bolt wherein the expansion device does not engage the head of the bolt nor any washer at the head end of the bolt.

Another object of the invention is to provide an expansion bolt which does not protrude downwardly from the roof of the mine in which used to any appreciable extent thus giving a maximum of headroom in the mine.

Another object of the invention is to provide an expansion bolt having means for adjusting the relative position of the bolt and the expansion device.

Still another object of the invention is to provide an expansion bolt having an expansion device which engages the surface of the hole over a large area to thus be usable in soft materials.

Another object of the invention is to provide an anchor expansion member which includes a modified volute or generally volute spring which may be readily expanded.

Another object of the invention is to provide a spring expansion member which may be expanded by two different actions.

Another object of the invention is to provide a spring expansion member wherein one end of the spring in its unstressed state engages the surface of the hole in which used.

Another object of the invention is to provide a spring of a left-hand spiral for use with a right-hand threaded bolt so that the friction of the threads causes radial expansion of the spring.

Still another object of the invention is to provide a spring expansion device which may be longitudinally compressed to provide radial expansion.

Other objects and a fuller understanding of this invention may be had by referring to the following descrip-

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tion and claims, taken in conjunction with the accompanying drawings, in which:

Figure 1 is a side view of the expansion device mounted in the hole;

Figure 2 is a side view similar to Figure 1 but with the spring radially expanded;

Figure 3 is a view similar to Figure 1 but showing a modification;

Figure 4 is a modified form of expansion device as assembled;

Figure 5 is a view of the expansion device of Figure 4 when inserted in a hole; and

Figure 6 is a view of the expansion device of Figure 5 when radially expanded.

Figures 1 and 2 show a side view of the complete expansion bolt 11 in an unclamped and a clamped condition, respectively. The complete expansion bolt 11 generally includes a long threaded rod or bolt 12, a modified volute spring 13, and a sleeve 14. The expansion bolt 11 has been shown as disposed within a hole 15 which has been drilled in earth or rock 16 which is the body to which the expansion bolt is to be fastened and may typically represent the various substances found in the roof of a mine.

The bolt 12 has an upper threaded end 20, a head 21, and passes through a hole 22 in a washer 23. This washer may be of any suitable size such as six or eight inches across in order to have satisfactory bearing surface with the roof of the mine. The bolt 12 may be of any suitable length.

The sleeve 14 has an outer surface 26 which fits within the spring 13. The sleeve 14 also has a female tapped surface 27 which threadably engages the bolt 12. Both the spring 13 and sleeve 14 may typically be made from steel or any other suitable material. The sleeve 14 preferably has a rather long length to closely engage the inner surface of the spring 13.

The spring 13 is a modified volute spring which is made from bar stock which is relatively wide and thin. The spring 13 has a first end 29 and a second end 30. The bar stock from which the spring 13 is wound should preferably be first bent on edge in order that a generally cylindrical spring can be wound with the adjacent turns somewhat overlapping. This is explained by the fact that the upper edge 31 of each turn of the spring has a larger radius than the lower edge 32; and hence, the upper edge 31 of the bar from which the spring is wound must be longer than the lower edge 32 of the bar. The bending on edge of the bar makes the upper edge 31 longer than the lower edge 32. Still further, the cross-sectional shape of the spring 13 is best shown at the upper portion of Figure 1 wherein it will be noted that the upper edge 31 of the spring is thicker than the lower edge 32. Still further, the preferred cross-sectional shape of the spring 13 is to have the upper edge turned outwardly to define a protruding edge which will define the outermost dimensions of the spring. Still further, as best shown in Figure 1, the spring 13 although generally cylindrical preferably has a slight conical taper with the upper or first end 29 being slightly smaller than the lower or second end 30. This protruding upper edge 31 will aid in digging into the surface of the hole 15 and thus firmly biting into this surface so that the expansion bolt 11 will not slip when tightened. The slightly conical shape of the spring 13 effectively increases the diameter of the second end 30 so as to cause this end at least to engage the surface of the hole 15. Also, the slightly conical shape may be considered as a means to cause the second end 30 of the spring 13 to engage the surface of the hole 15.

The Figures 1 and 2 show that the spring first end 29 is securely attached to the sleeve 14 as by a rivet 35.

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This assures that when the sleeve 14 is caused to rotate, then the spring first end will also rotate therewith. Still further, if the sleeve 14 is caused to move longitudinally, the spring first end 29 will also move longitudinally.

Operation

The parts of the expansion bolt 11 may be assembled, and then the complete expansion bolt 11 inserted in the hole 15 of the roof of the mine 16 or other body to which the bolt is to be attached, as shown in Figure 1. The slightly conical shape of the spring 13 establishes that the mid-portion of the spring will first engage the surface of the hole 15. As the spring 13 is longitudinally inserted into the hole 15, the mid-portion or lower end of the spring 13 hitting the hole surface 15 will cause longitudinal expansion of the spring 13 which will thus radially compress it to enable it to readily be inserted into the hole 15. The complete bolt 11 is inserted until the washer 23 is engaging both the mine roof 16 and the bolt head 21. The bolt 12 may then be rotated to tighten the bolt into the sleeve 14. It will be noted that the spiral of the thread 20 and of the spring 13 are of opposite hand; namely, the bolt being a right-hand thread and the spring 13 being a left-hand spiral. By rotating the bolt 12, this does not change the longitudinal position of the bolt since the head 21 abuts the washer 23 which abuts the mine roof. However, such rotation does cause longitudinal downward movement of the sleeve 14. The second end 30 of the spring, having previously been in engagement with the surface of the hole 15, remains in engagement therewith and resists the downward movement. Thus, the longitudinal downward movement of the sleeve 14 causes longitudinal compression of the spring 13 with consequent radial expansion thereof to lock it into the surface of the hole 15, as shown in Figure 2.

Another novel feature of the invention is that with the bolt thread and spring spiral being of opposite hand the friction between the bolt threads and the female threads on the sleeve 14 tends to cause a rotation of the spring first end 29 in a direction to radially expand the spring. Thus, a double action is obtained by threading and tightening the bolt 12 into the sleeve 14.

If the hole 15 is slightly undersized for a particular size of spring 13, then more of the length of the spring will engage the surface of the hole 15 as it is being pushed upwardly into initial position. If the hole 15 is slightly oversized, then only the lowermost end of the spring 13 will engage the hole surface 15 as the entire bolt 11 is being pushed upwardly into initial position. By making the conicity of the spring 13 slightly greater, an even greater range of sizes of holes can be accommodated by one size of spring 13.

The Figure 3 shows a modification wherein a separate sleeve 14 is not used. Instead, two or three turns 38 at the spring first end 29 are wound upon each other, and then suitably fastened together such as by weld metal 39. The interior surface of these pluralities of turns 38 is then tapped as at 40 to provide a female thread for engagement with the male threads on the bolt 12. By this construction of Figure 3 the need for a separate sleeve 14 is eliminated.

The Figures 4, 5, and 6 show another form of expansion device or expansion bolt 44 which again may be used with the bolt 12 and includes a modified volute spring 45 and a sleeve 46. This modification of Figures 4, 5, and 6 shows a simpler version as far as manufacturing since the cross section of the spring 46 is generally rectangular or it may have a parallelogram shape to give a sharp edge as at 47 to aid in biting into the surface of the hole 15. Approximately, the first turn at the upper end of the spring 45 which is fastened in any suitable manner to the sleeve 46 has an in-turned edge 48.

The Figure 4 shows the spring 45 generally in its unstressed state wherein the several coils of the spring 45 overlap considerably and the longitudinal length is rather

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short. This aids in the winding of the spring. The Figure 5 shows the spring as inserted into the hole 15. In this case the in-turned edge 48 helps the first turn of the spring to slide into the hole and then the sharp edges 47 on the remainder of the turns dig into the surface of the hole 15 to longitudinally stretch and hence radially compress the spring so that it will enter the hole 15. The Figure 6 shows the complete expansion bolt 44 after the bolt 12 has been turned to draw the sleeve 46 downwardly thus longitudinally compressing the spring 45 and hence radially expanding it.

The spring of Figures 1 and 2 may preferably be constructed in the same way so that the spring has a short longitudinal length when it is merely assembled on the bolt 12 but not inserted in the hole, and then the friction of the spring 13 on the surface of the hole 15 will lengthen it out to the position shown in Figure 1. Alternatively, it may have the shape shown in Figure 1 in the unstressed state and dependent upon the fact that the lower end of the spring engages the surface of the hole 15 to hold it in that position; and then when the sleeve 14 is moved downwardly as the bolt 12 is rotated, this longitudinal compression will cause the radial expansion as shown in Figure 2.

By any of the constructions of Figures 1, 3, or 5 the sleeve or member bearing the female threads is fastened to the spring first end 29 or at least frictionally engages the spring first end for both rotational and longitudinal interengagement. The bolt 12 is a central rod which cooperates with the spring first end 29 and especially by having a threaded connection therewith provides a means for longitudinally adjusting the position of the spring first end 29 relative to the bolt 12. This gives assurance that only the washer 23 and head 21 will protrude downwardly below the roof of the mine, thus giving a maximum of headroom in the mine. This is far superior to the use of a long threaded lower end on the bolt 12 with a nut engaging this threaded end below the washer 23 since in such case the long threaded end would protrude dangerously below the roof of the mine when the expansion bolt was tightened in place.

The fact that the anchor expansion device utilizes a radially expandible member spring 13 or 45 which is springy assures that the device will radially contract and longitudinally expand when the bolt 12 is loosened. There is thus no permanently distorted member in the entire device; and hence, the entire anchor bolt 11 is reusable should it no longer be needed in its old location.

The Figures 1, 2, 5, and 6 show that the lower end of the spring 13 or 45 does not engage the washer 23, rather it engages only the surface of the hole 15 and thus no long tube or pipe extending from the washer 23 to the lower end 30 of the spring 13 is required. This is another saving in cost and complexity and thus another advantage.

It will also be noticed that the spring 13 or 45 engages the surface of the hole 15 throughout the entire periphery of the spring and over a majority of the length of the spring. This establishes a relatively large area of the spring 13 or 45 in engagement with the surface of the hole. Further, the softer the material of the mine roof 16, the larger the area of the spring 13 or 45 which is in contact with the hole surface. This, therefore, establishes that the entire expansion bolt is readily usable with both hard and soft materials of the roof of the mine.

Although this invention has been described in its preferred form with a certain degree of particularity, it is understood that the present disclosure of the preferred form has been made only by way of example and that numerous changes in the details of construction and the combination and arrangement of parts may be resorted to without departing from the spirit and the scope of the invention as hereinafter claimed.

What is claimed is:

1. An expansion device for use in an opening in a

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solid body, comprising a modified volute steel spring of a plurality of turns formed from a relatively wide and thin bar stock, said spring being generally conical with the upper end thereof of slightly smaller diameter than the lower end thereof and each turn of said spring overlapping the upwardly adjacent turn when the spring is in an unstressed state to establish a protruding edge for engaging the wall of the opening, the said upper edge being thicker than the said lower edge of the spring and being directed angularly outward with respect to the remainder of the spring along the helical length thereof and forming a bearing surface for engagement with the wall of the opening and resisting downward movement of the spring relative to the solid body along the helical length of the spring, metal sleeve means disposed inside the first end of the said spring and means to fixedly attach said sleeve means to the said first end, a thread on the interior of the said sleeve, a male bolt threaded in said sleeve at the upper end of the bolt, the bolt extending upwardly through the spring from the lower to the upper end thereof, said volute spring being wound in a left-hand spiral and said bolt having a right-hand thread, the diameter of the body opening being slightly greater than said spring first end and slightly less than said spring second end to thus cause the middle portion of said spring to first engage said roof hole surface upon the spring being inserted first end first in said roof hole, and the friction between said male bolt threads and said sleeve threads tending to rotate and expand the said spring first end and the longitudinal compression of said spring tending to radially expand the spring as the bolt is threaded into said sleeve with corresponding longitudinal movement of said sleeve.

2. An expansion device adapted to be used with a bolt for insertion in an opening in a solid body to transmit tension between the said bolt and the said solid body, the bolt having a fixed head and a threaded end portion for insertion into the opening, comprising an elongate spiral member having a plurality of turns of generally rectangular cross section with the longer dimension thereof disposed in the direction of the longitudinal axis of the bolt, the top part of each turn being of slightly greater diameter than the bottom part of the turn and overlapping the bottom part of the upwardly preceding turn with the upper part of the turn deformed outwardly to constitute a protruding edge for gripping the wall of the opening, the diameter of the turns increasing in progressing downwardly from the upper end of the member to impart a generally conical disposition to the member and a free lower end for initially gripping the wall of the opening, sleeve means at the upper end of the spiral member rotationally

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and longitudinally fixed with respect to that member and with a female threaded opening for receiving the threaded end portion of the bolt, the sleeve means constituting the radially innermost extremity of the device for permitting the bolt to pass upward through the spiral member and the spiral member being wound in opposite hand direction relative to the sleeve, whereby rotation of the bolt tends to expand the spiral member into engagement with the walls of the opening.

3. An expansion device adapted to be used with a bolt for insertion in an opening in a solid body to transmit tension between the said bolt and the said solid body, the bolt having a fixed head and a threaded end portion for insertion into the opening, comprising an elongate spiral member having a plurality of turns of generally rectangular cross section with the longer dimension thereof disposed in the direction of the longitudinal axis of the bolt, the top part of each turn being of slightly greater diameter than the bottom part of the turn and overlapping the bottom part of the upwardly preceding turn with the outward corner of the turn constituting a protruding edge for gripping the wall of the opening and with each turn tapered upwardly to form a cross section of increasing thickness toward the top of the turn for reinforcing the spiral member along the portion thereof engaged with the walls of the opening and for increasing the grip upon the walls of the opening, the diameter of the turns increasing in progressing downwardly from the upper end of the member to impart a generally conical disposition to the member and a free lower end for initially gripping the wall of the opening, sleeve means at the upper end of the spiral member rotationally and longitudinally fixed with respect to that member and with a female threaded opening for receiving the threaded end portion of the bolt, the sleeve means constituting the radially innermost extremity of the device for permitting the bolt to pass upward through the spiral member and the spiral member being wound in opposite hand direction relative to the sleeve, whereby rotation of the bolt tends to expand the spiral member into engagement with the walls of the opening.

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