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3,133,468

TENSION INDICATING DEVICE

Filed March 21, 1961

2 Sheets-Sheet 1

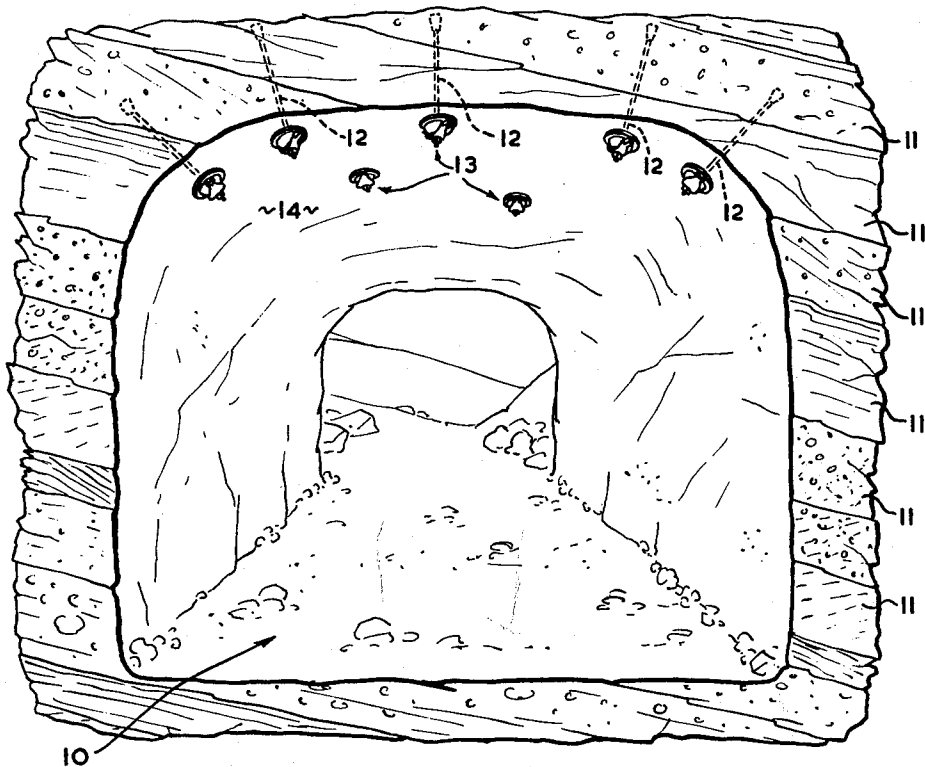
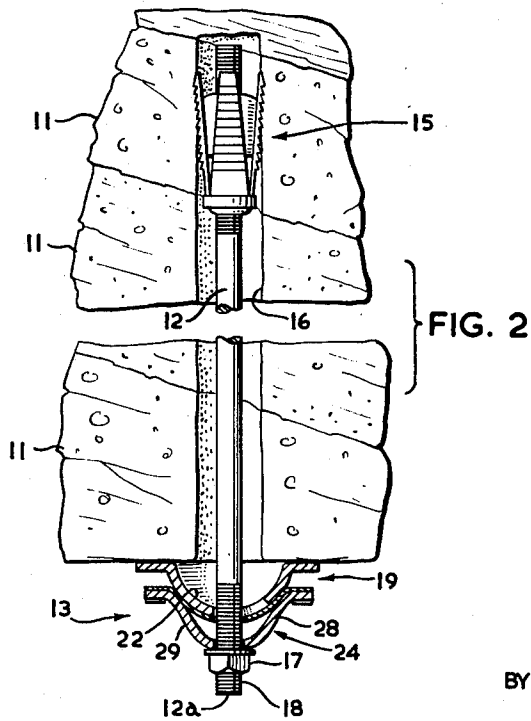


FIG. 1



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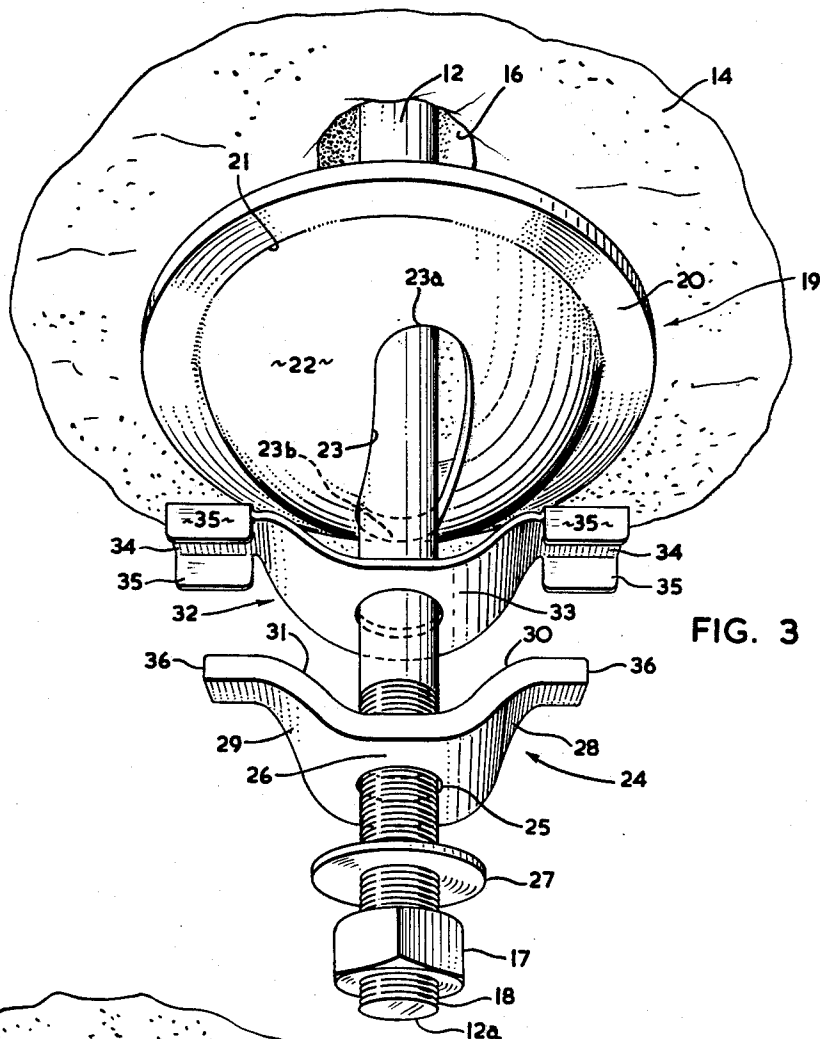


FIG. 3

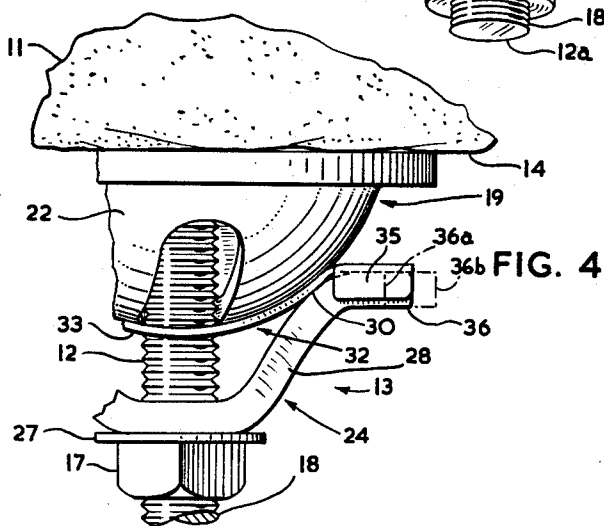


FIG. 4

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1 Claim. (Cl. 85-62)

This invention relates to tension indicating devices and, in particular, to a tension indicating device which, when used in association with a bolt and nut assembly, is capable of giving a visual indication of the tension in the bolt caused by tightening the nut on the bolt.

The invention has particular application for use in association with bolt and nut assemblies of the type known as "rock bolts" which are devices used in mining and other excavating work to secure the rock walls of such excavations against partial or total collapse.

It is an object of the present invention to provide a device of this nature which is economical to manufacture, simple to use and install, which will give a readily obtainable indication of the tension in the bolt by visual means and which does not require special skills or tools either to apply or to use.

The invention will be illustrated by way of example in the following description and in the accompanying drawings in which like reference numerals denote like parts in the various views and in which:

FIGURE 1 is a perspective view of a mine tunnel to which rock bolts including the tension indicating devices of the present invention are applied;

FIGURE 2 is a detailed cross-sectional view through a portion of FIGURE 1 showing one of the rock bolts with a tension indicating device in position;

FIGURE 3 is a still further enlarged view, in perspective, of a portion of a rock bolt and a tension indicating device in exploded position, and

FIGURE 4 is a side elevation view of a tension indicating device in its operative state.

Referring now to the drawings in detail and, in particular, to FIGURE 1, it will be observed that there has been provided an excavation or tunnel 10 of the type commonly employed in the mining art. The tunnel 10 has been driven through rock which, in the example illustrated, may be seen to comprise a plurality of adjacent layers or strata, several of which are indicated by reference characters 11. In FIGURE 1 it will be seen that a plurality of rock bolts, each bearing a reference numeral 12 have been installed in the roof of the tunnel 10 for the purpose of binding adjacent strata 11 together to prevent the partial or complete collapse of the tunnel roof. Each of the rock bolts 12 may be seen to be fitted with a tension indicating device, generally bearing reference character 13.

Turning now to FIGURE 2, it may be seen that a rock bolt 12 is provided with an expandable head 15 which, when the rock bolt 12 has been inserted in a suitably provided drilling 16 formed in the rock mass, passing through at least one interface between adjacent strata 11, may be expanded to grip the walls of the drilling 16 so as to secure the bolt in the position shown in FIGURES 1 and 2.

Before proceeding with a detailed description of the tension indicating device 13 which is illustrated in somewhat greater detail in FIGURES 2, 3 and 4, it is convenient to point out that since the function of the rock bolts is to bind adjacent strata 11 together at their interface, so as to prevent the partial or complete collapse of the walls of the tunnel or excavation, it is necessary that this binding be achieved by imparting a tension in the bolt 12 so as to hold the adjacent strata into frictional engagement with one another. It is clear that a certain degree of tension is necessary in order to adequately

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achieve this object. Similarly, of course, an excessive tension in the bolts 12 may cause the bolts to break or may cause them to elongate beyond the elastic limits of the material from which they are made. Either of these conditions is, of course, undesirable since the device would then no longer serve its intended purpose. Similarly, once the bolt has been installed and a proper tension imparted to it, it is necessary that this tension be maintained since if, for any reason, this tension would be relaxed or dissipated, the bolt would, under these conditions, also fail to achieve its intended purpose.

The degree of tension which is required will vary from one installation to another and will depend upon many factors such as the inherent stability of the rock within which the bolt is installed, the diameter of the bolt, the tensile strength of the material from which it is made and many other factors, none of which are of any real significance to the present invention. The present invention is, however, concerned with providing means whereby a workman may readily determine when the correct tension has been imparted to the bolt 12 at the time of installation and which will enable him readily to determine, upon subsequently checking the installation, whether the tension has been maintained, dissipated or increased for any one of a number of reasons.

Turning now to FIGURE 3 of the drawings, the rock bolt 12 may be seen extending from the drilling 16 in the rock face 14. The free end 12a extends downwardly from the rock face 14 and is provided, adjacent the end 12a, with a suitably screw-threaded portion 18.

When studying FIGURE 3 it will be apparent that the screw-threaded portion 18 does not, in the illustrated embodiment, extend for a sufficient distance along the bolt 12 for the nut 17 to be tightened so as to bring the component parts into contact with one another. It must therefore be assumed that either the rock bolt 12 may and will be inserted further into the drilling 16 or that the threads, although not so illustrated, will extend along the bolt 12 for a distance sufficient for the device to be operative.

The tension indicating device includes first of all a washer, indicated generally by reference character 19, which consists of an annular peripheral flange 20 surrounding, and integrally formed with the base 21 of a central domed portion 22 which is provided with an aperture 23 for the passage of the bolt 12. The aperture 23 may be in the form of a slot lying along a line of longitude of the domed portion. The slot extends from a first end 23a which lies adjacent the flange 20 to a second end 23b which is so located that the bolt 12 may pass through the aperture 23 with the axis of the bolt concentric with the flange 20 and with the flange 20 normal to the axis of the bolt.

The washer 19 is formed of a material such as steel which is thick enough to enable it to withstand the compressive force necessary to impart the desired tension to the bolt 12 without experiencing any noticeable deformation. The portion 22 is domed, since, as is well known, a domed member can support a greater compressive force than a flat surface of equivalent thickness and for all practical purposes, the washer 19 may be considered to be incompressible due to a force exerted along the axis of the bolt 12 when the bolt 12 is in a position such that it passes through the aperture 23.

The tension indicating device comprises, as an essential feature, the U-shaped member 24 which is provided with a central aperture 25 through which the bolt 12 may pass. The area 26 surrounding the central aperture 25 constitutes a bearing surface against which the nut 17 may bear. Preferably, a hardened planar washer 27 lies between the nut 17 and the bearing surface 26 so that as the

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nut 17 is tightened down, it will turn against the washer 27 and will not gall or dig into the material of the U-shaped member 24.

The U-shaped member 24 is formed with two legs 28 and 29, each of which is provided, adjacent its end, with a second bearing surface, bearing surface 30 being provided on leg 28 and, bearing surface 31 being provided on leg 29, which second bearing surfaces are adapted to lie on the surface of the domed portion of the washer 19, preferably through the medium of a sheet metal protective member 32 which, for the moment, will be ignored.

The distance between the bearing surfaces 30 and 31 will be seen to be less than the maximum diameter of the domed portion 22 of the washer 19 so that these bearing surfaces will lie upon the domed surface of the central portion 22 of the washer 19 at positions such as those illustrated in FIGURES 2 and 4.

Returning now to FIGURE 2, it will be seen that as the nut 17 is tightened on the threaded portion 18 of the free end 12a of the rock bolt 12, the domed portion 22 of the washer 19 will be forced between the legs 28 and 29 of the U-shaped member 24 and will urge the legs 28 and 29 apart. The U-shaped member 24 is made of a resilient material such as steel and is of a thickness such that the force required to spread the legs apart is commensurate with the tension which it is desired to impart to the bolt 12.

In FIGURE 3, one embodiment of the sheet metal protective member 32 may be seen to comprise a central portion 33 which is of a curvature complementary to the curvature of the domed portion 22 of the washer 19 so that, as seen in FIGURE 4, it will lie adjacent the surface 22 of the washer 19. The ends of the protective member 32 are provided with outwardly extending tabs 34 the side edges of which may conveniently be provided with flanges 35 which, with the tabs 34 define channels within which the extremities 36 of the legs 28 and 29 of the U-shaped member may rest. The protective member 32 performs two important functions. First, it eliminates the wear or abrasion of the domed portion 22 of the washer 19 by the action of the U-shaped member as the bearing surfaces 30 and 31 move thereover during application, removal, and adjustment of the device. Second, it carries the tabs 34 and flanges 35 which constitute reference points against which the position of the extremities of the legs of the U-shaped member may be measured.

In FIGURE 4, the tension indicating device 13 is shown in its operative state. The bolt 12 has been installed within the rock strata 11 by inserting it in a suitable drilling and the buried end of the bolt 12 is engaged within the aperture by means of an expanding head such as that shown, for example, at 15 in FIGURE 2. Over the free end 12a of the bolt 12 there has been applied, first of all the washer 19, secondly the protective member 32, thirdly the U-shaped member 24, fourthly the planar washer 27 and finally the nut 17. As the nut 17 is tightened down on the bolt 12 it bears, through the medium of the washer 27, on the area 26 surrounding the central aperture in the U-shaped member 24 through which the bolt 12 passes. As the nut bears on this area of the U-shaped member 24 the bearing areas 30 and 31 bear against the domed surface 22 of the washer 19 through the medium of the sheet metal protective member 32. In FIGURE 4 only bearing area 30 of leg 28 is illustrated and it may be seen to contact the sheet metal protective member 32 with the extremity 36 of the leg 28 lying within the channel formed by flanges 35 and the tabs 34 on the protective member 32.

Since the sheet metal protective member 32 conforms to the curvature of the domed portion 22 of the washer 19, its configuration and position is not affected by the tension in the bolt 12 and its position is substantially fixed relative to the washer 19. Tightening of the nut 17, however, forces the domed portion 22 between the

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legs 28 and 29 of the U-shaped member 24 and forces them apart, the greater the tension, the greater the distance through which they are forced apart and the lesser the tension, the smaller the distance through which they are forced apart. Thus, the distance between the bearing surfaces 30 and 31 is a function of the tension in the bolt 12 and this distance can readily be measured by visually comparing the position of the extremity 36 of the legs 28 and 29 relative to the fixed position of the extremities of the flanges 35 carried by the sheet metal protective member 32.

In FIGURE 4 the extremity 36 of leg 28 of the U-shaped member 24 is shown in full lines to be flush with the extremities of the flanges 35 carried by the protective member 32. Conveniently, this position may represent a tension in the bolt 12 which is the optimum for the particular location within which the bolt is installed and the function which it is to perform. Accordingly, when the bolt is being installed, the workman tightens the nut 17 until the extremity 36 of the legs 28 and 29 lie flush with the outer edges of the flanges 35 carried by the protective member 32.

Subsequently, upon checking these installations at a later time to determine whether the bolts are still at the correct tension, he need merely glance at the tension indicating devices and if the extremity 36 is still flush with the extremity of the flanges 35, then he is able to conclude that the tension is still being maintained at the desired level. If, however, the tension has been relaxed, the U-shaped members 24 will have, due to their inherent resilience, "climbed" up on the surface of the domed portion 22 of the washer 19 and the extremity 36 of the legs 28 and 29 may then lie, for example, at the position indicated by the dotted line 36a in FIGURE 4.

Alternatively, the tension may have increased during the elapsed time between installation and subsequent checking, due to one or more of several reasons such as, for example, a shifting in the rock strata. If the tension has increased, then the dome 22 will have been forced further into the space between the bearing surfaces 30 and 31 in the U-shaped member 24 and the extremities 36 of the legs of the U-shaped members might, for example, lie at positions such as that indicated by the dotted line 36b in FIGURE 4.

From the foregoing description it will be readily apparent that a simple, economical and efficient tension indicating device has been provided which may be applied and used without special skills and without special tools. The tension in the bolt may be determined within the limits of accuracy necessary in practice, by a simple, visual inspection which will readily disclose whether or not the extremities of the legs of the U-shaped members are in the desired position relative to the tabs and flanges carried by the protective sheet metal strip 32.

In addition to achieving the objects set forth earlier in this specification, the invention possesses certain advantages which are of importance. First of all, the bolts 12 are slightly elongated by the tension which is normally imparted to them. If the rock face 14 (see FIGURE 4) were to be crushed under the tension imparted to the bolt 12, only a slight such crushing might be sufficient to entirely dissipate the tension in the bolt 12 if the only resilience in the entire structure which achieved the tension were that derived from the elongation of the bolt 12. The tension is also maintained, however, by the resilient deformation of the U-shaped member 24 which may be of a greater magnitude when measured in a direction along the axis of the bolt 12 than is the resilient elongation of the bolt itself. Accordingly, before the tension in the bolt 12 will be completely dissipated by the movement of the washer 22 towards the rock face in the direction of the applied tension, the rock face 14 must be crushed to a much greater extent when the present invention is used than would be the case if no such U-shaped member 24 were employed. Accordingly,

slight crushing or "spalling" of the rock, although undesirable even with the present invention, does not produce a complete dissipation of the tension as has been found to be the case in certain devices of the prior art.

Some devices of the prior art also enabled a reading of the tension in bolt 12 to be obtained, but only by the use of special tools which measured certain deformations of material used. Such tools were not altogether convenient to use, subject to damage in the rather rough conditions of a mine and were, accordingly, less than satisfactory. An example of this latter form of prior art device may be seen in Belgian Patent No. 527,435 issued on April 15, 1954 and assigned to Wingfoot Corporation of Akron, Ohio, United States of America. The present invention does not require any special tools either for installation or to obtain a reading sufficiently accurate for the intended purpose and the task of periodically checking the rock bolts to determine whether the desired tension is being maintained is very much simplified and accelerated.

Although a preferred embodiment of the invention has been described in detail by way of illustration, it is to be understood that modifications of the structure, shape, arrangement and configuration of the components illustrated, is contemplated within the spirit of the invention and the scope of the appended claim.

What I claim as my invention is:

Structure for use in association with a bolt and nut assembly to indicate the tension in the bolt as a result of the tightening of the nut on the bolt; comprising a washer consisting of an annular peripheral flange surrounding and integrally formed with a domed central portion having an aperture through which the bolt may pass with the domed portion extending towards the nut, a sheet metal protective member lying on the central

domed portion of the washer and provided with an aperture through which the bolt may pass, a resilient, generally U-shaped member having a central aperture through which the bolt may pass, the area surrounding the aperture consisting of a first bearing surface upon which the nut, through the medium of a hardened planar washer may bear, the legs of the U-shaped member each having a second bearing surface adjacent its end adapted to bear on the domed portion of the washer through the medium of the sheet metal protective member, the distance between the second bearing surfaces of the legs of the U-shaped member in its relaxed state, being less than the maximum diameter of the domed portion of the washer, the tightening of the nut on the bolt forcing the U-shaped member against the washer and urging the legs of the U-shaped member to spread apart as the domed portion of the washer is forced between them, the sheet metal protective member having an edge lying adjacent each leg of the U-shaped member, the position of the edges being substantially fixed relative to the domed portion and which constitutes a reference point from which to determine the distance between the extremities of the legs of the U-shaped member, said distance, due to the resilience of the U-shaped member, being a function of the tension in the bolt.

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