

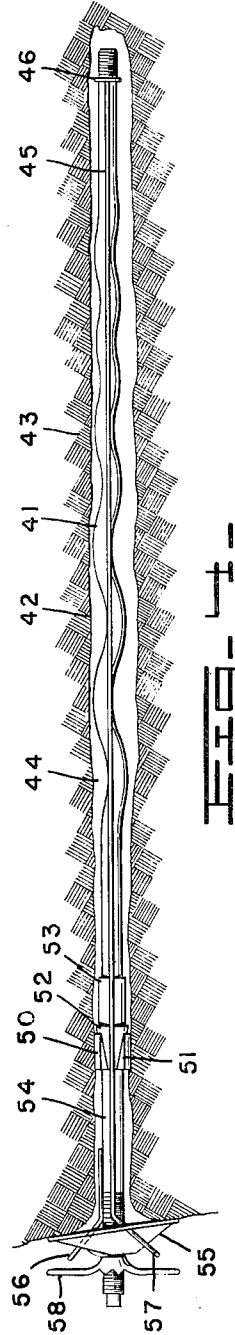
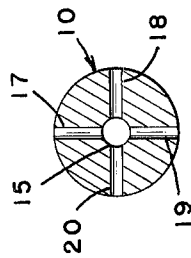
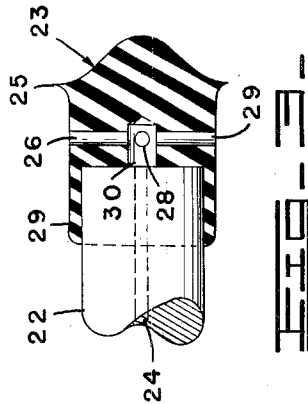
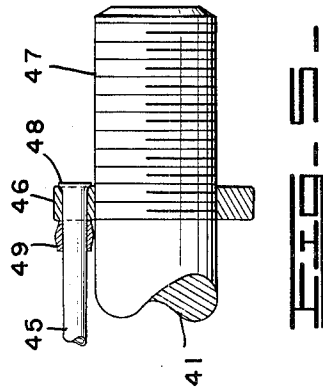
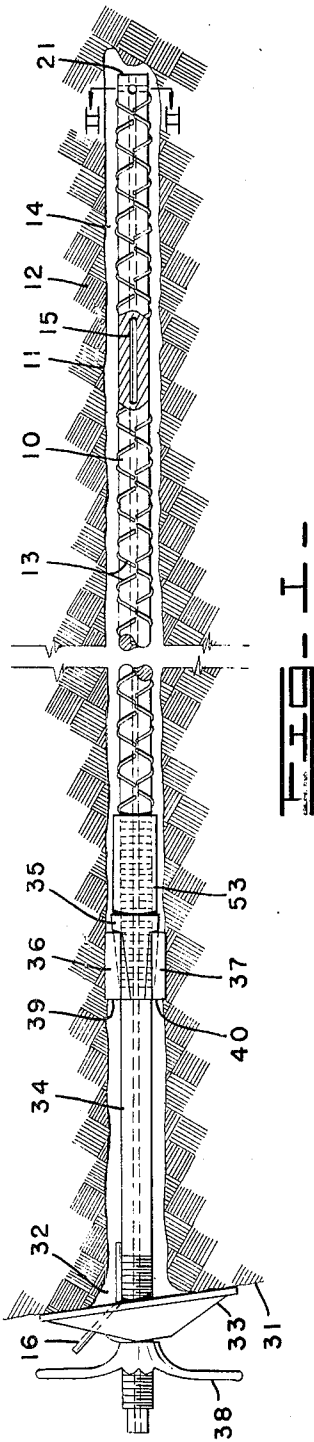
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GROUTABLE ROCK ANCHOR

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GROUTABLE ROCK ANCHOR
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2 Claims. (Cl. 61—45)

This invention relates to anchoring devices used in construction projects; and particularly to the type that is placed in a hole drilled in a rock formation, and locked in position with a cement mixture. This type of device is particularly useful in securing the rock formation itself in the area adjacent the project. When the installation of these devices has been completed, they may be used also to anchor forms in position for confining liquid concrete as it is poured. The anchors are usually in the form of rods extending into holes to a depth of from 4 to 20 feet. The insertion of the cementitious grout under pressure has the effect of providing a uniform bond between the anchor and the rock over substantially the entire length of the bore hole. It also seals off water seepage and fills seams and voids in the formation along the drilled hole.

Grouted anchors are not broadly new, and the present invention provides an improved construction that simplifies installation and assures adequate application of the grout. It is conventional to inject the grout near the surface of the bore hole, and to provide a vent near the inner extremity of the bore hole for the escape of the entrapped air as the grout progressively fills the hole. The vent extends from the inner extremity of the bore hole to the surface, and the emergence of the grout at this vent is the accepted indication of the completion of the grout application. To seal the anchor in place during the injection of the grout, and to close off the bore hole at the surface for developing the required liquid pressure, it is common practice to temporarily lock the anchor rod in the hole to provide forces necessary to clamp a cover plate against a seal. It has been conventional to place this temporary anchor at the inner extremity of the anchor rod, and applicant has discovered that the installation of the anchor is considerably simplified by the placement of the temporary holding device adjacent the surface where it is more readily accessible to tools inserted at the bore opening. The fixing of the gripping device in engagement with the rock is also accomplished without the accompaniment of a deflection of the anchor unit over the entire length of the bore hole.

Applicant has also discovered that the use of an undulated anchor rod provides a very substantial increase in efficiency over the use of a conventional corrugated-surface straight rod. The undulated anchor in a small hole has an effect which is in addition to its functions when such an anchor is incorporated in large masses of concrete. The tendency for the undulated rod to deflect under load causes a tendency for the axis to move toward a straight line. Such action has a corresponding tendency to force the surrounding grout more securely into engagement with the rock at the wall of the bore hole, and the holding power is thereby increased.

The installation of vent tubes has required special attention when solid-section rods are used, and when temporary anchors are used at a position adjacent the surface of the bore holes. To supply the grout at the entrance of the bore hole, the supply flow must traverse the temporary holding unit. The present invention provides a structure which satisfies these requirements, and also provides for the exhaust of the entrapped air at a point slightly outward from the inner extremity of the rod. This feature tends to minimize the possibility that rock particles might become entrapped in the vent, and interfere with the flow of the entrapped air.

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The several features of the invention will be analyzed in further detail through a discussion of the particular embodiments illustrated in the accompanying drawing. In the drawing:

FIGURE 1 presents a sectional view of a typical installation of a groutable rock anchor including a straight-axis anchor rod with a roughened outer surface, and showing the use of a surface-type temporary holding device in conjunction with this type of anchor rod, and further illustrating the use of cross-hole at the inner extremity of the rod for vent purposes.

FIGURE 2 presents a section on a transverse plane, and on an enlarged scale, at the plane II—II of FIGURE 1.

FIGURE 3 illustrates a modified form of the invention in which an auxiliary end-fitting is used to provide the transverse vent holes.

FIGURE 4 illustrates a modified form of the invention in which an undulated anchor rod of solid cross-section is used, together with a straight vent tube extending over the major portion of the length of the anchor,

FIGURE 5 presents a fragmentary view on an enlarged scale showing the securing of the inner end of the vent tube on the FIGURE 4 arrangement.

Referring to FIGURE 1, the anchor rod 10 is shown inserted in the bore 11 in the rock formation 12. The rod 10 is of the straight-axis type, with the surface irregularities indicated at 13 formed in a compound helical pattern along the entire length of the rod to increase the gripping action between the rod and the grout which is to be inserted later in the space 14 between the rod and the wall of the bore 11. The hollow interior of the rod 10 forms a conduit 15 for the escape of entrapped air as the grout is pumped in at the entrance tube fitting 16. As the space 14 is progressively filled by the grout, the entrapped air moves into the passage 15 either through the open end of the rod 10, or through any one of the lateral passages 17-20. The arrangement of these passages is best shown in FIGURE 2 and they are formed by cross-drilling on perpendicular diameters. This multiplicity of openings, particularly the passages 17-20 which are slightly set back from the inner end 21 of the rod 10, minimizes the possibility that the flow of air might become blocked by the presence of dust or rock chips from the formation of the bore 11.

As an alternative to the cross-drilling arrangement illustrated in FIGURE 2, an auxiliary end fitting may be incorporated as shown in FIGURE 3. The anchor rod 22 is of the same type as the rod 10 of FIGURE 1, and the fitting 23 is slipped over the end of the rod 22 to provide the entrance passage into the interior conduit 24 through which the entrapped air escapes. The end fitting 23 is preferably of rubber or some material that is at least semi-resilient, and may be provided with the annular lip 25 which acts as a piston to sweep rock chips and dust ahead of it during the insertion of the rod to leave the area occupied by the passages 26, 27, and 28 as free as possible of such material. The presence of the lip 25 also tend to leave at least some space between the peripheral surface 29 of the fitting 23 and the wall of the rock bore 11 to facilitate the escape of the air through all of the passages. It is preferable that the central chamber 30 be of somewhat larger diameter than the passage 24 in the rod in order to assure that the passage 24 will communicate as freely as possible without obstruction.

As the grout is pumped in through the intake fitting 16, considerable pressure is developed at the entrance as the bore 11 intersects with the surface 31. In order to seal against this pressure, it is common to apply a mass of sealing composition in the area indicated at 32, and to cover this with a plate 33 which is capable of considerable articulation with respect to the axis of the hole 11 in order

to accommodate the possible angularity between the plane of the surface 31 and the axis of the extension 34. To secure the position of the anchor assembly as the grout pressure is being applied, a temporary holding device is used which includes the conical plug 35 and the shoes 36 and 37. These shoes have an inner surface which mates with the conical periphery of the plug 35, and tension on the extension 34 will tend to pull the plug 35 axially with respect to the shoes 36 and 37. The resulting radial separating action will cause a tight engagement between the shoes and the wall of the rock bore 11. Tightening of the nut 38 will establish the necessary clamping action, and the engagement of the nut 38 with the plate 33, particularly when reinforced by the presence of sealing compound at the area noted at 32, will provide the necessary seal for the proper application of grout under pressure. It should be noted that the shoes 36 and 37 are separate, and the space between them forms a channel for the axial movement of the grout along the extension 34 and the rod 10. In initially establishing the jamming action which creates the outward movement of the shoes 36 and 37 against the rock, it is often necessary to reach in through the opening of the bore (prior to the installation of the plate 33) with a section of pipe in order to tap the outer ends 39 and 40 of the shoes to induce some degree of axial movement with respect to the plug 35. This expansion may also be induced by a thrust ring (not shown) mounted on the extension 34. The presence of these shoes adjacent to the surface 31—well within the reach of conventional hand tools—will considerably facilitate the installation of the assembly. In instances in which a rotary movement is necessary to establish a gripping action in a holding device, the presence of the unit near the surface will eliminate the torsional deflection of the major length of the assembly.

Referring to FIGURE 4, the undulated anchor rod 41 is shown inserted in the bore 42 in a rock formation 43. The undulations in the axis of the rod 41 may be of the type shown and described in my Application for United States Patent Serial No. 76,339 now Patent No. 3,160,988. In a rock bore which may run to excessive length, however, the undulations may be of a constant-amplitude, rather than the gradient type shown in FIGURE 4. In any event, the undulated axis of the rod has a very significant effect when an anchor of this type is applied to a grouted bore in a rock formation. It is obvious that any significant amount of pull on the rod which will be sufficient to cause substantial deflection will have a tendency to cause the undulations to move very slightly toward positioning the axis of the rod along a straight line. Any such deflection will tend to move sections of the surrounding grout in the space 44 between the rod and the bore 42 more securely against the wall of the bore. This increase in gripping action will often result in decreasing the required length of the rod and bore for a given installation.

In the FIGURE 4 modification, the entrapped air is evacuated through the tube 45 which terminates in the disc 46 in a manner best shown in FIGURE 5. Preferably, the end 47 of the rod 41 is threaded, with the disc 46 having a corresponding thread on its internal surface which engages with the threaded end 47. A suitable hole is drilled in the disc 46 for receiving the tube 45, and the end 48 is expanded or peened over to secure the position of a tube 45 with respect to the rod assembly. A ring 49 may be slipped over the end of the tube 45 before engagement with the disc 46 in order to obtain the proper axial position of the tube and the disc for the peening operation at 48, and also to oppose any tendency of the tube 45 to slide to the right with respect to the remainder of the assembly. The ring 49 is preferably a snug fit with respect to the exterior of the vent tube 45.

It will be noted that the tube 45 extends between the shoes 50 and 51 of the temporary holding device which also includes the tapered plug 52. This assembly is of

the same nature as that described in connection with FIGURE 1, and the coupling 53 is preferably incorporated in both cases to transfer the stresses from extensions 54 and 34 over to the anchor rods 41 and 10, respectively. In this arrangement, the plugs 35 and 52 are received on the extensions 34 and 54, with the extensions engaging the respective couplings. The articulating surface plate 55 is similar to the plate 33 of FIGURE 1, and the grout-supply fitting 56 is similar to the fitting 16 of FIGURE 1. The vent tube 45 emerges from a suitable hole in the plate 55 as shown at 57 to provide for the escape of the entrapped air. The nut 58 is similar to the nut 31, and the installation of the assembly shown in FIGURE 4 follows that described in connection with FIGURE 1.

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. A groutable anchor assembly for engagement with the wall of a hole bored in a rock formation, said hole having a mouth, said anchor assembly comprising: a stress-resisting rod of substantial length having inner and outer end portions and adapted for insertion axially into said hole with said outer end portion adjacent said mouth and said inner end portion being deformed; temporary rock-gripping means disposed intermediate said portions nearer the outer end than the inner end and including circumferentially spaced shoes readily accessible from said mouth and adapted to be engaged with the wall of said hole and engaging said outer portion of said rod, said spaced shoes defining a channel between said inner and outer portions for the introduction of grout, said temporary rock-gripping means being adapted to restrain said assembly against retraction while permitting insertion thereof relative to said wall, said rock-gripping means in gripping position projecting radially beyond said rod; a removable surface plate of larger area transverse to said rod than the cross section of said rock-gripping means in gripping position, said plate having an aperture receiving said outer portion; means for applying force between said surface plate and said temporary means via said outer portion and including a threaded portion on said outer portion and nut means engaging said threaded portion and said plate; grout-supply means intersecting said surface plate; and means forming a vent conduit extending substantially from said surface plate and between said shoes to a point adjacent to the inner end of said rod.

2. A groutable anchor assembly for engagement with the wall of a hole bored in a rock formation, said hole having a mouth, said anchor assembly comprising: a stress-resisting rod of substantial length having inner and outer end portions and adapted for insertion axially into said hole with said outer end portion adjacent said mouth and said inner end portion being undulated; temporary rock-gripping means disposed intermediate said portions nearer the outer end than the inner end and including circumferentially spaced shoes readily accessible from said mouth and adapted to be engaged with the wall of said hole and engaging said outer portion of said rod, said spaced shoes defining a channel between said inner and outer portions for the introduction of grout, said temporary rock-gripping means being adapted to restrain said assembly against retraction while permitting insertion thereof relative to said wall, said rock-gripping means in gripping position projecting radially beyond said rod; a removable surface plate of larger area transverse to said rod than the cross section of said rock-gripping means in gripping position, said plate having an aperture receiving said outer portion; means for applying tension to said rod between said surface plate and said temporary rock-gripping means; and vent means and a grout inlet open-

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ing intersecting said surface plate, said vent means traversing said channel between said shoes and extending substantially from said surface plate and between said shoes to a point adjacent to the inner end of said rod.

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