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Method of Installing a Rock Strata Tendon

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Abstract

The present invention is broadly directed to an apparatus 10 for installing a tendon 12 within a cavity of a rock strata (not shown), said apparatus 10 comprising:

1. roller means 14 adapted to grip the tendon 12 having a distal end 16 located in an entrance of the rock cavity to be supported by the tendon 12;
2. a rotary actuator 18 operatively coupled to the roller means 14 to effect its rotation thereby enabling predominantly axial sliding of the gripped tendon 12 into the cavity.

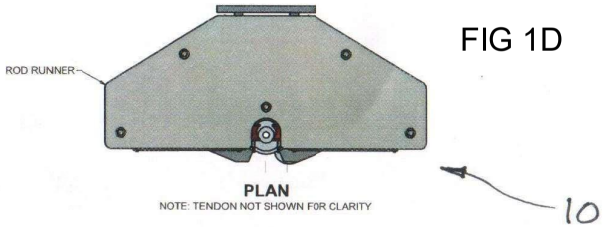

FIG 1D

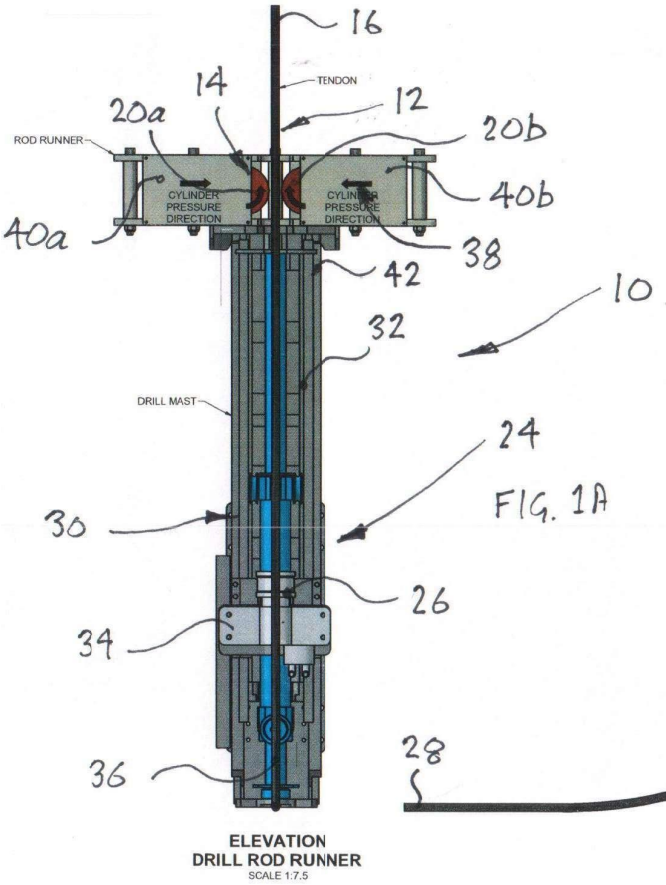

FIG 1A

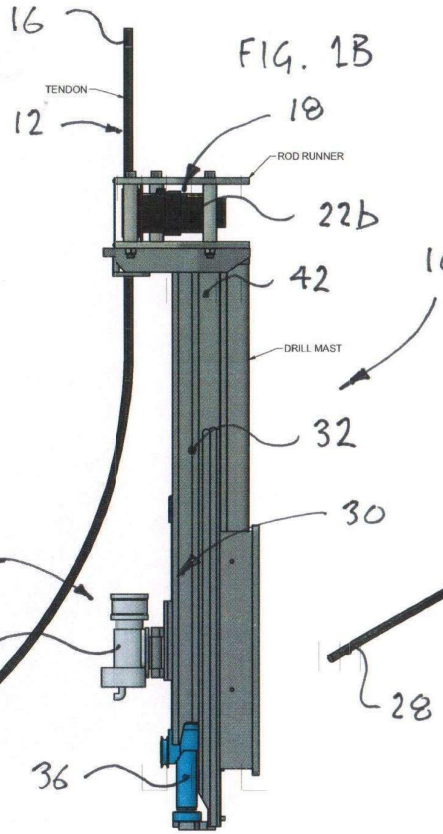

FIG 1B

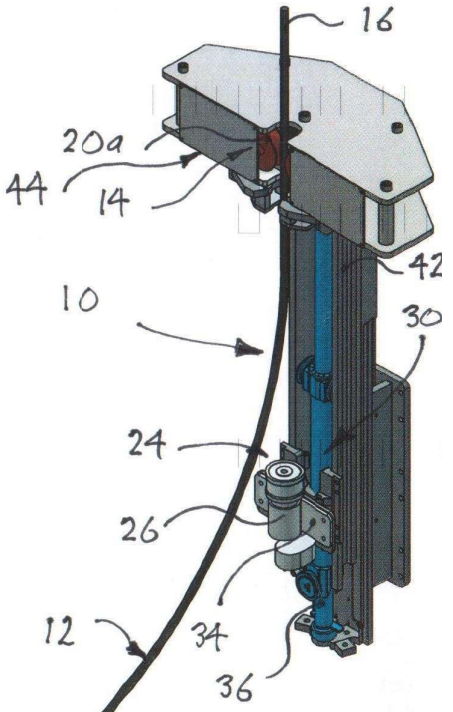

FIG 1C

METHOD OF INSTALLING A ROCK STRATA TENDON

Technical Field

[0001] The present invention is broadly directed to a method of installing a tendon within a cavity of a rock strata. The invention is also generally directed to an apparatus for installing a rock strata tendon.

Background of Invention

[0002] Australian patent no. 719385 is directed to a method of reinforcing rock with a tendon. The tendon is rotatably driven into a bore using a drilling rig which includes a drive motor slidably mounted to a vertical slide via a carriage. The tendon is encapsulated in the bore with anchoring material so that the tendon can be tensioned. The drive motor includes a chuck through which the tendon passes in the course of its insertion into the bore. The drive motor commences at the bottom of the slide for gripping and then rotation of the tendon via the chuck. The drive motor moves up the slide during rotation of the tendon. The drive motor halts rotation and releases its grip on the tendon which slides through the chuck when the drive motor is returned to the bottom of the slide. These steps are repeated to insert the tendon in the bore where it is tensioned after it is anchored in position at the upper end of the bore. The tendon is thus simultaneously rotated and slid into the bore using the drilling rig. The rotation of the tendon assists in its passage through the anchoring material in which it is encapsulated.

[0003] It is to be understood that any acknowledgement of prior art in this specification is not to be taken as an admission that this prior art is common general knowledge in the relevant art.

Summary of Invention

[0004] According to a first aspect of the invention there is provided an apparatus for installing a tendon within a cavity of a rock strata, said apparatus comprising:

roller means adapted to grip the tendon having its distal end located in an entrance of the rock cavity to be supported by the tendon;

a rotary actuator operatively coupled to the roller means to effect its rotation thereby enabling predominantly axial sliding of the gripped tendon into the cavity.

[0005] Preferably the roller means includes a pair of opposing rollers adapted for gripping the tendon to facilitate the axial sliding of the tendon into the cavity. More preferably the pair of rollers are about respective of their peripheral contact surfaces constructed of a resiliently flexible material which at least in part conforms to the tendon when gripped thereby promoting the axial sliding of the tendon into the cavity with reduced slippage. Even more preferably the rotary actuator includes a pair of motors operatively coupled to respective of the pair of rollers which are counter-rotated relative to one another via respective of the pair of motors. Still more preferably the pair of drive motors are synchronously operated to enable simultaneous rotation of the pair of rollers to enable axial thrusting of the gripped tendon into the cavity.

[0006] Preferably the apparatus also comprises anchoring means including rotation means adapted to releasably engage a proximal end of the tendon for rotation whilst the distal end of the tendon is slid into a blind end of the cavity via a sliding actuator to which the rotation means is operatively coupled. More preferably the sliding actuator includes a mast to which a carriage is slidably coupled, the rotation means being mounted to the carriage. Even more preferably the rotation means includes a hydraulic motor mounted to the carriage. Still more preferably the sliding actuator includes a drive mechanism including a hydraulically actuated cylinder mounted to a proximal end of the mast and operatively coupled to the carriage to effect its sliding movement along the mast.

[0007] Preferably the apparatus further comprises clamping means operatively coupled to the rotary actuator to effect releasable clamping of the associated roller means about the tendon. More preferably the clamping means includes a pair of slidable mounting brackets to which respective of the pair of motors are mounted, said mounting brackets being movable relative to one another for releasable clamping of the pair of rollers about the tendon. Still more preferably the clamping means also includes a clamping actuator operatively coupled to one or both of the mounting

brackets for enabling the relative movement of said mounting brackets and thus clamping of the pair of rollers about the tendon.

[0008] Preferably the pair of mounting brackets are mounted to the mast at its distal end adjacent the entrance to the cavity. More preferably said mounting brackets are slidably mounted to a masthead bracket fixed to the mast at its distal end.

[0009] According to a second aspect of the present invention there is provided a method of installing a tendon within a cavity of a rock strata, said method comprising:

locating a distal end of the tendon in an entrance of the cavity of the rock strata to be supported by the tendon;

inserting the tendon into the cavity by (i) gripping the tendon with roller means, and (ii) rotating said roller means to enable predominantly axial sliding of the gripped tendon into the cavity.

[0010] Preferably the tendon is gripped with the roller means in the form of a pair of opposing rollers. More preferably the axial sliding movement of the gripped tendon into the cavity is enabled by counter-rotation of the pair of rollers relative to one another thereby axially thrusting the tendon into the cavity.

[0011] Preferably the method also comprises anchoring of the tendon by engaging a proximal end of the tendon with rotation means which simultaneously rotates and slides a distal end of the tendon into a blind end of the cavity independent of the pair of rollers which are released from the tendon.

[0012] Preferably the anchoring of the tendon involves pre-installing resin or grout within the blind end of the cavity in preparation for anchoring of the tendon at its distal end. More preferably the simultaneous rotation and sliding of the tendon into the blind end of the cavity via the rotation means promotes mixing of the pre-installed resin or grout via a resin mixer located at the distal end of the tendon.

[0013] Preferably the method also comprises tensioning of the tendon within the cavity following its anchoring at the blind end of the cavity. More preferably the

tensioned tendon is thereafter substantially fully encapsulated with additional resin or grout in the cavity.

Brief Description of Drawings

[0014] In order to achieve a better understanding of the nature of the present invention a preferred embodiment of a method an apparatus for installing a tendon within a cavity of a rock strata will now be described, by way of example only, with reference to the accompanying drawings in which:

Figures 1A to 1D are various views of an apparatus for installing a tendon of a preferred embodiment of a first aspect of the invention;

Figures 2A to 2D are staged illustrations in elevation depicting a method of installing a tendon according to a preferred embodiment of a second aspect of the invention.

Detailed Description

[0015] As seen in figures 1A to 1D there is an apparatus 10 for installing a tendon 12 within a cavity of a rock strata (not shown). The apparatus 10 of this embodiment of the first aspect of the invention broadly comprises:

1. roller means 14 adapted to grip the tendon 12 having a distal end 16 located in an entrance of the rock cavity to be supported by the tendon 12;
2. a rotary actuator 18 operatively coupled to the roller means 14 to effect its rotation thereby enabling predominantly axial sliding of the gripped tendon 12 into the cavity.

[0016] In this embodiment the roller means 14 includes a pair of opposing rollers 20a and 20b adapted for gripping the tendon 12 to facilitate the axial sliding of the tendon 12 into the cavity. The rollers 20a/b are about their peripheral contact surfaces constructed of a resiliently flexible material which in part conforms to the tendon 12 when gripped. In this example the resiliently flexible material is a rubber compound which on gripping conforms to the tendon 12 thereby promoting sliding of the tendon 12 into the cavity with reduced slippage. The rotary actuator 18 includes a pair of hydraulic motors 22a and 22b operatively coupled to respective of the pair of

rollers 20a and 20b. The pair of rollers 20a/b are counter-rotated relative to one another via respect of the pair of motors 22a/b which are synchronously operated to enable simultaneous rotation of the pair of rollers 20a/b. This synchronous counter-rotation of the pair of rollers 20a/b enables axial thrusting of the gripped tendon 12 into the cavity.

[0017] The apparatus 10 of this embodiment also comprises anchoring means designated generally at 24 including rotation means 26 adapted to releasably engage a proximal end 28 of the tendon 12 for rotation (not shown). The tendon 12 is rotated via the rotation means 26 whilst the distal end 16 of the tendon 12 is slid into a blind end of the rock cavity via a sliding actuator depicted generally at 30 to which the rotation means 26 is operatively coupled. In this example the sliding actuator 30 includes a mast 32 to which a carriage 34 is slidably coupled, the rotation means 26 being mounted to the carriage 34. The rotation means 26 of this embodiment is in the form of a hydraulic motor mounted to the carriage 34. Finally, the sliding actuator 30 includes a drive mechanism 36 in the form of a hydraulically actuated cylinder mounted to a proximal end of the mast 32, and coupled to the carriage 34 to effect its sliding movement along the mast 32.

[0018] The apparatus 10 of this embodiment further comprises clamping means schematically depicted by arrows at 38 operatively coupled to the rotary actuator 18 to effect releasably clamping of the pair of rollers 20a/b about the tendon 12. The clamping means 38 includes a pair of slidable mounting brackets 40a and 40b to which respective of the pair of hydraulic motors 22a and 22b are mounted. The mounting brackets 40a/b are movable relative to one another thereby enabling releasable clamping of the corresponding pair of rollers 20a/b about the tendon 12. In this example the clamping means 38 also includes clamping actuators (not shown) operatively coupled to one or both of the mounting brackets 40a/b for enabling the relative movement of said mounting brackets 40a/b and thus clamping of the corresponding pair of rollers 20a/b about the tendon 12.

[0019] In this embodiment the pair of mounting brackets 40a/b are mounted to the mast 32 at its distal end 42 adjacent the entrance to the rock cavity. In this particular

construction the mounting brackets 40a/b are slidably mounted to a mast head bracket 44 fixed to the mast 32 at its distal end 42.

[0020] As seen in figures 2A to 2D there is a method of installing a tendon such as 12 in a cavity 50 of a rock strata 52. In this embodiment of a second aspect of the invention the method is described in the context of the apparatus 10 of the embodiment of the first aspect. To avoid repetition and for ease of reference the method of the second aspect has in this embodiment been described with reference to like components of the apparatus 10 of the first aspect. In this embodiment of the second aspect the method broadly comprises the steps of:

1. locating a distal end 16 of the tendon 12 in an entrance 54 of the cavity 50 of the rock strata 52 to be supported by the tendon 12;
2. inserting the tendon 12 into the cavity 50 by (a) gripping the tendon 12 with roller means 14, and (b) rotating the roller means 14 to enable predominantly axial sliding of the gripped tendon 12 into the cavity 50.

[0021] It is to be understood that figures 2A to 2D sequentially illustrate the staged installation of the tendon 12 within the cavity 50 according to the preferred method of this aspect of the technology.

[0022] Figure 2A best depicts insertion of the tendon 12 into the cavity 50 where the tendon 12 is gripped with the roller means 14 in the form of a pair of opposing rollers 20a and 20b. The axial sliding of the gripped tendon 12 into the cavity 50 is enabled by counter-rotation of the pair of rollers 20a/b relative to one another thereby axially thrusting the tendon 12 into the cavity 50.

[0023] Figures 2B and 2C best illustrate anchoring of the tendon 12 in a blind end (not shown) of the cavity 50. In this embodiment anchoring of the tendon 12 is effected by:

1. engaging the proximal end 28 of the tendon 12 with rotation means 26;
2. simultaneously rotating and sliding the distal end 16 of the tendon 12 into the blind end of the cavity 50 independent of the pair of rollers 20a/b which are released from the tendon 12.

[0024] It will be understood that simultaneous rotation and sliding of the tendon 12 is enabled by the sliding actuator 30 wherein the hydraulic motor 26 being mounted to the carriage 34 is slid along the mast 32 under the action of the hydraulically actuated cylinder 36. The pair of rollers 20a/b of the roller means 14 are released from the tendon 12 to permit this simultaneous rotation and sliding of the tendon 12.

[0025] In a conventional manner anchoring of the tendon 12 involves pre-installation of resin or grout within the blind end of the cavity 50 for anchoring of the tendon 12 at its distal end 16. The simultaneous rotation and sliding of the tendon 12 into the blind end of the cavity 50 promotes mixing of the pre-installed resin or grout via an optional resin mixer (not shown) located at the distal end 54 of the tendon 12.

[0026] As seen in figure 2D the method of this embodiment also comprises tensioning of the tendon 12 within the cavity 50 following its anchoring at the blind end of the cavity 50. In the illustrated embodiment this tensioning is effected by a barrel and wedge arrangement 55 being tensioned via a hydraulic tensioner 56 or alternatively a conventional torque tensioning device. The tensioned tendon 12 is thereafter fully encapsulated without additional resin or grout in the cavity 50, nominally occupying half the length of cavity 50. It will be understood that resin or grout cartridges may be arranged so that the uppermost cartridge has a relatively quick setting resin for anchoring of the tendon prior to tensioning whereas the remaining resin cartridges are relatively slow setting for full encapsulation of the tendon.

[0027] Now that a preferred embodiment of the alternative aspects of the invention have been described it will apparent to those skilled in the art that the apparatus and method for installing a tendon within a rock strata have at least the following advantages:

1. the tendon can be installed in a predominantly sliding action without the need for rotation of the tendon until it approaches the blind end of the cavity;
2. the apparatus and method are relatively quick in installing tendons where the axial sliding of the tendon into the cavity is continuous without requiring any planned interruptions;

3. the apparatus and method avoid rotation of the tendon during its installation and thus provide quicker and safer operation underground particularly in confined spaces with limited strata ceiling heights.

[0028] Those skilled in the art will appreciate that the invention as described herein is susceptible to variations and modifications other than those specifically described. For example, one only of the counter-rotating rollers may be actively driven wherein the other of the rollers functions as an idler roller. In this alternative construction one only of the rollers may be moved into gripping engagement with the tendon whilst the other roller remains stationary. The specific construction of the anchoring means may depart from the mast and carriage embodiment provided the tendon is effectively anchored at the blind end of the cavity. For example, the roller means and rotary actuator may not only effect installation of the tendon into the majority of the cavity but also its anchoring at the blind end of the cavity where for example rotation is not required for mixing of the resin or grout.

[0029] All such variations and modifications are to be considered within the scope of the present invention the nature of which is to be determined from the foregoing description.

Claims

1. An apparatus for installing a tendon within a cavity of a rock strata, said apparatus comprising:

roller means adapted to grip the tendon having its distal end located in an entrance of the rock cavity to be supported by the tendon;

a rotary actuator operatively coupled to the roller means to effect its rotation thereby enabling predominantly axial sliding of the gripped tendon into the cavity.

2. An apparatus as claimed in claim 1 wherein the roller means includes a pair of opposing rollers adapted for gripping the tendon to facilitate the axial sliding of the tendon into the cavity.

3. An apparatus as claimed in claim 2 wherein the pair of rollers are about respective of their peripheral contact surfaces constructed of a resiliently flexible material which at least in part conforms to the tendon when gripped thereby promoting the axial sliding of the tendon into the cavity with reduced slippage.

4. An apparatus as claimed in either of claims 2 or 3 wherein the rotary actuator includes a pair of motors operatively coupled to respective of the pair of rollers which are counter-rotated relative to one another via respective of the pair of motors.

5. An apparatus as claimed in claim 4 wherein the pair of drive motors are synchronously operated to enable simultaneous rotation of the pair of rollers to enable axial thrusting of the gripped tendon into the cavity.

6. An apparatus as claimed in either of claims 4 or 5 also comprising anchoring means including rotation means adapted to releasably engage a proximal end of the tendon for rotation whilst the distal end of the tendon is slid into a blind end of the cavity via a sliding actuator to which the rotation means is operatively coupled.

7. An apparatus as claimed in claim 6 wherein the sliding actuator includes a mast to which a carriage is slidably coupled, the rotation means being mounted to the carriage.

8. An apparatus as claimed in claim 7 wherein the rotation means includes a hydraulic motor mounted to the carriage.

9. An apparatus as claimed in either of claims 7 or 8 wherein the sliding actuator includes a drive mechanism including a hydraulically actuated cylinder mounted to a proximal end of the mast and operatively coupled to the carriage to effect its sliding movement along the mast.

10. An apparatus as claimed in any one of claims 7 to 9 further comprising clamping means operatively coupled to the rotary actuator to effect releasable clamping of the associated roller means about the tendon.

11. An apparatus as claimed in claim 10 wherein the clamping means includes a pair of slidable mounting brackets to which respective of the pair of motors are mounted, said mounting brackets being movable relative to one another for releasable clamping of the pair of rollers about the tendon.

12. An apparatus as claimed in claim 11 wherein the clamping means also includes a clamping actuator operatively coupled to one or both of the mounting brackets for enabling the relative movement of said mounting brackets and thus clamping of the pair of rollers about the tendon.

13. An apparatus as claimed in either of claims 11 or 12 wherein the pair of mounting brackets are mounted to the mast at its distal end adjacent the entrance to the cavity.

14. An apparatus as claimed in claim 13 wherein said mounting brackets are slidably mounted to a masthead bracket fixed to the mast at its distal end.

15. A method of installing a tendon within a cavity of a rock strata, said method comprising:

locating a distal end of the tendon in an entrance of the cavity of the rock strata to be supported by the tendon;

inserting the tendon into the cavity by (i) gripping the tendon with roller means, and (ii) rotating said roller means to enable predominantly axial sliding of the gripped tendon into the cavity.

16. A method as claimed in claim 15 wherein the tendon is gripped with the roller means in the form of a pair of opposing rollers.

17. A method as claimed in claim 16 wherein the axial sliding movement of the gripped tendon into the cavity is enabled by counter-rotation of the pair of rollers relative to one another thereby axially thrusting the tendon into the cavity.

18. A method as claimed in either of claims 16 or 17 also comprising anchoring of the tendon by engaging a proximal end of the tendon with rotation means which simultaneously rotates and slides a distal end of the tendon into a blind end of the cavity independent of the pair of rollers which are released from the tendon.

19. A method as claimed in claim 18 wherein the anchoring of the tendon involves pre-installing resin or grout within the blind end of the cavity in preparation for anchoring of the tendon at its distal end.

20. A method as claimed in either of claims 18 or 19 wherein the simultaneous rotation and sliding of the tendon into the blind end of the cavity via the rotation means promotes mixing of the pre-installed resin or grout via a resin mixer located at the distal end of the tendon.

21. A method as claimed in either of claims 19 or 20 also comprising tensioning of the tendon within the cavity following its anchoring at the blind end of the cavity.

22. A method as claimed in claim 21 wherein the tensioned tendon is thereafter substantially fully encapsulated with additional resin or grout in the cavity.

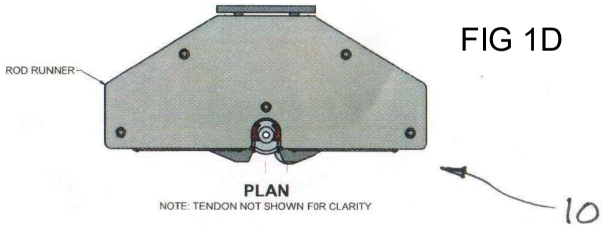

FIG 1D

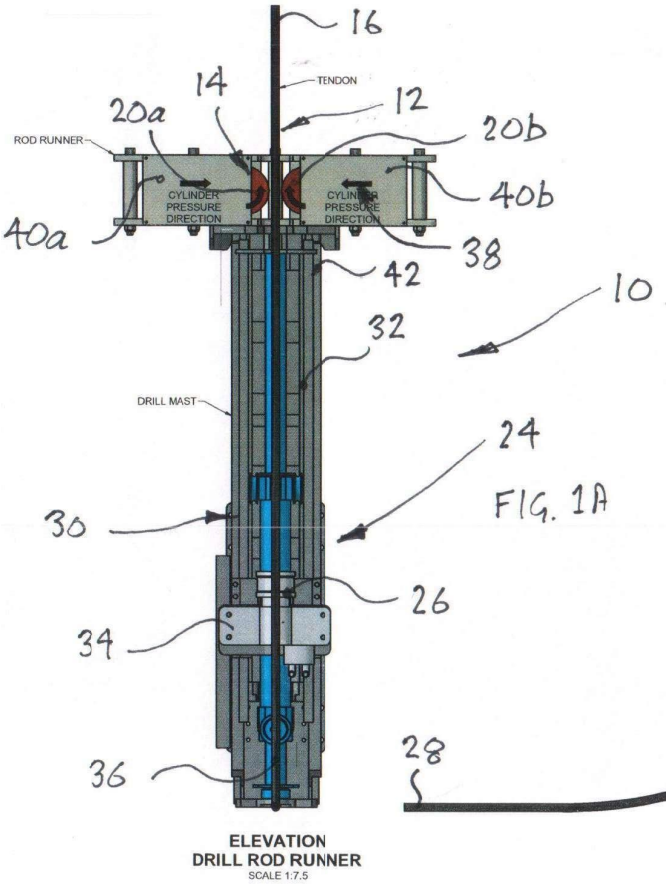

FIG 1A

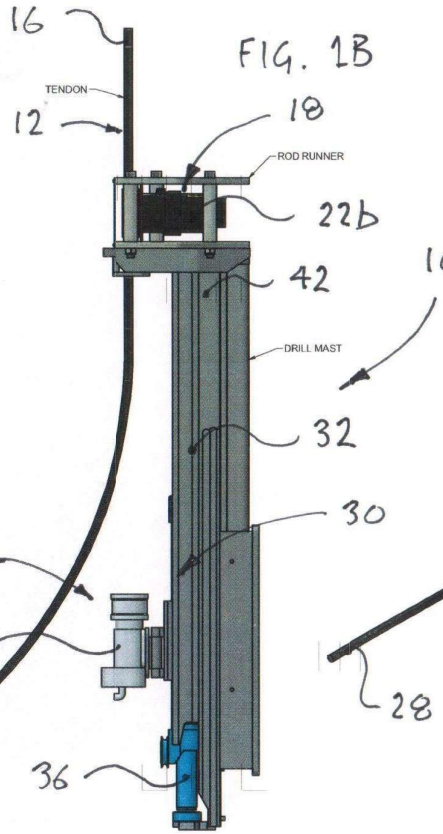

FIG 1B

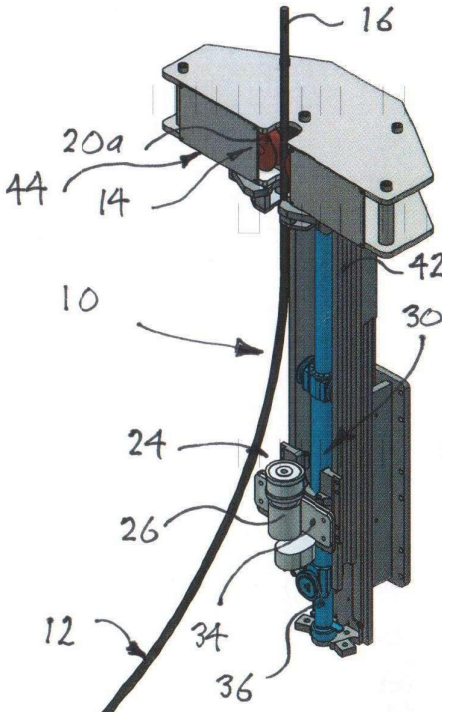

FIG 1C

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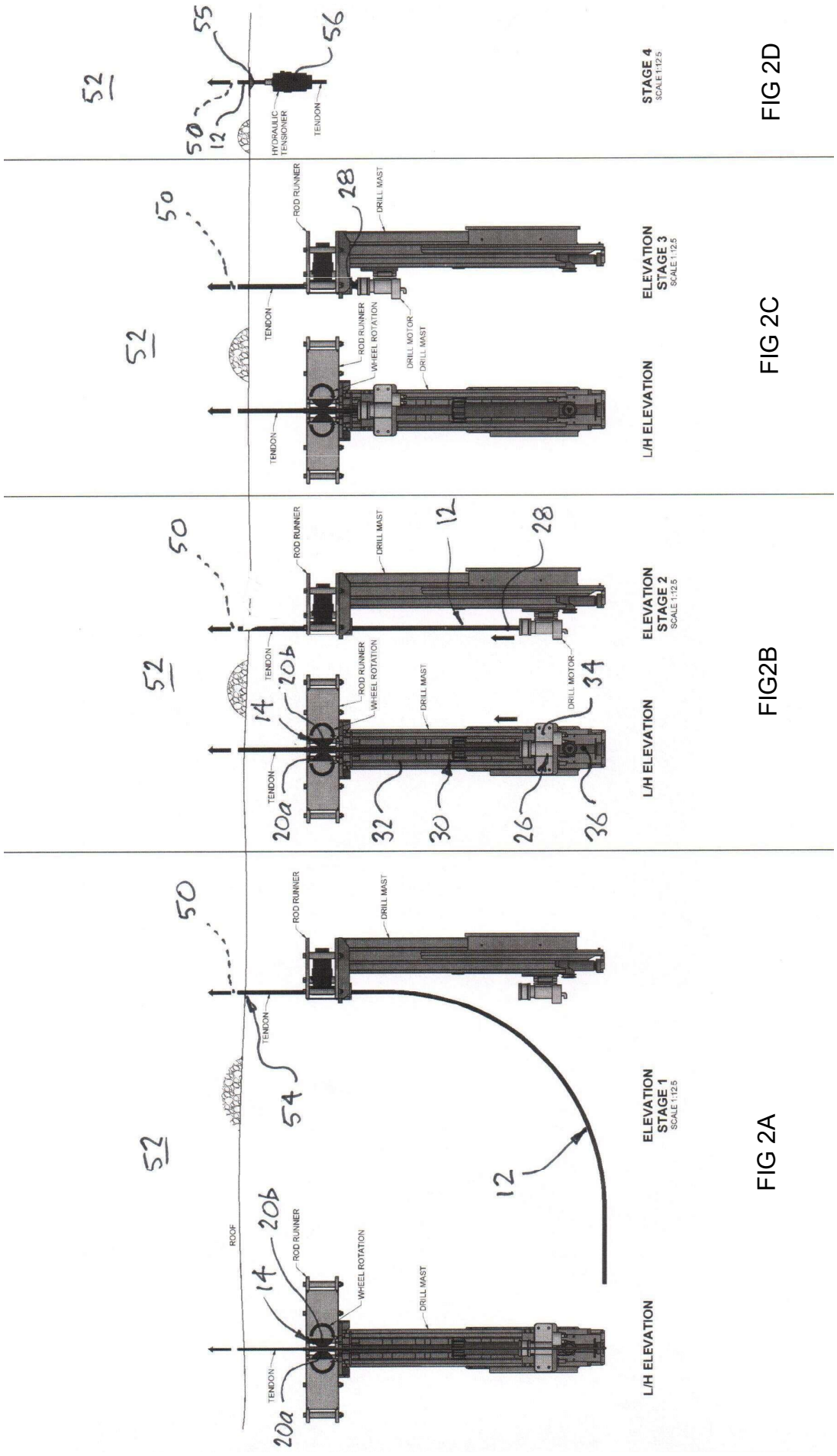

FIG 2A

FIG2B

FIG 2C

FIG 2D