Dec. 26, 1967 C. E. BLATTER 3,359,742

METHOD AND APPARATUS FOR SECURING ANCHORAGE IN LOOSE AND COMPACT GROUND

Original Filed July 11, 1963 4 Sheets-Sheet 1

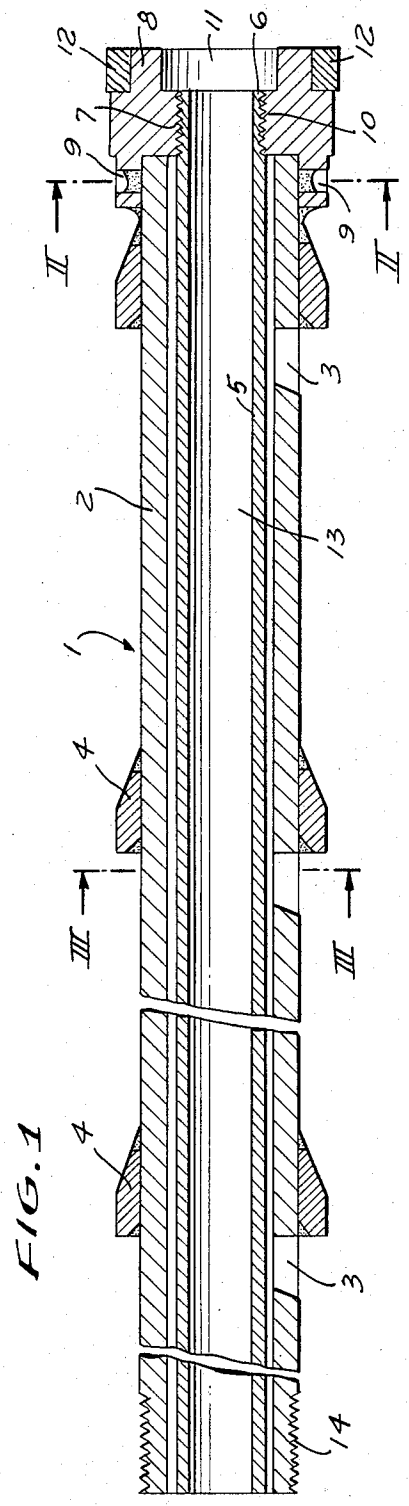


FIG. 1

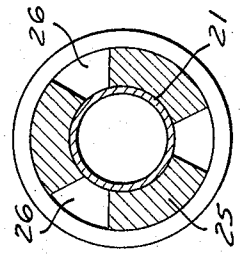


FIG. 7

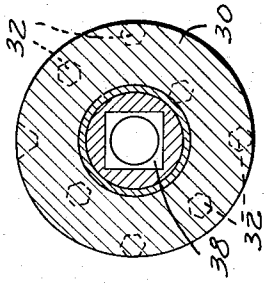


FIG. 6

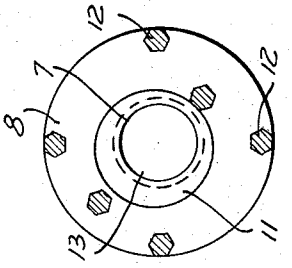


FIG. 4

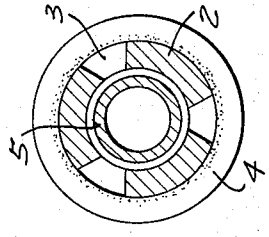


FIG. 3

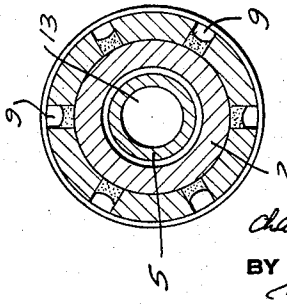


FIG. 2

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METHOD AND APPARATUS FOR SECURING ANCHORAGE IN LOOSE AND COMPACT GROUND

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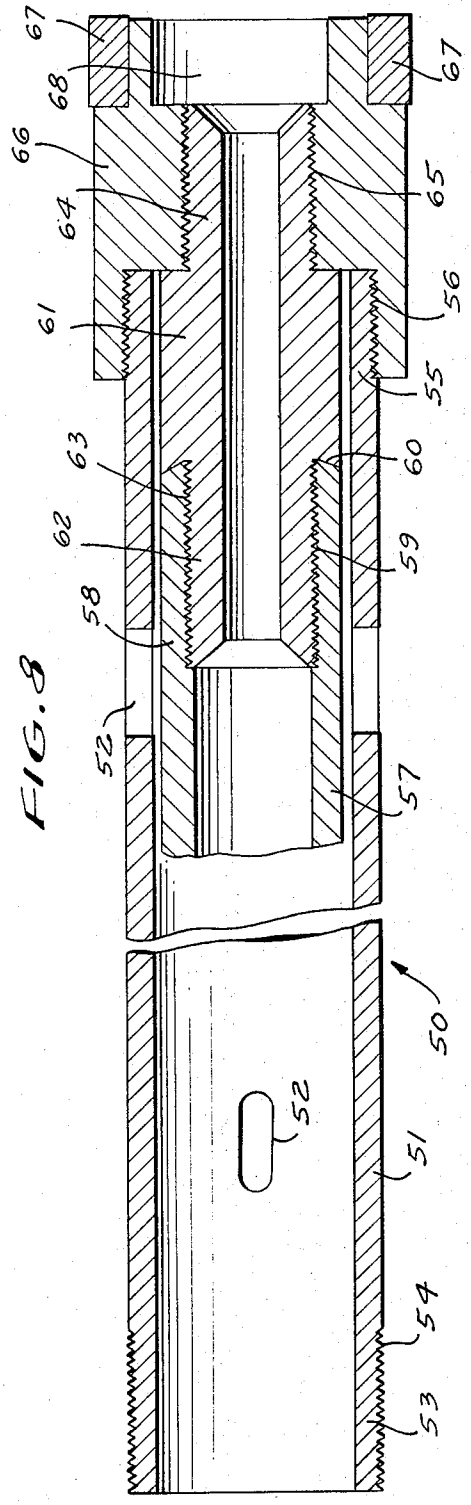


FIG. 8

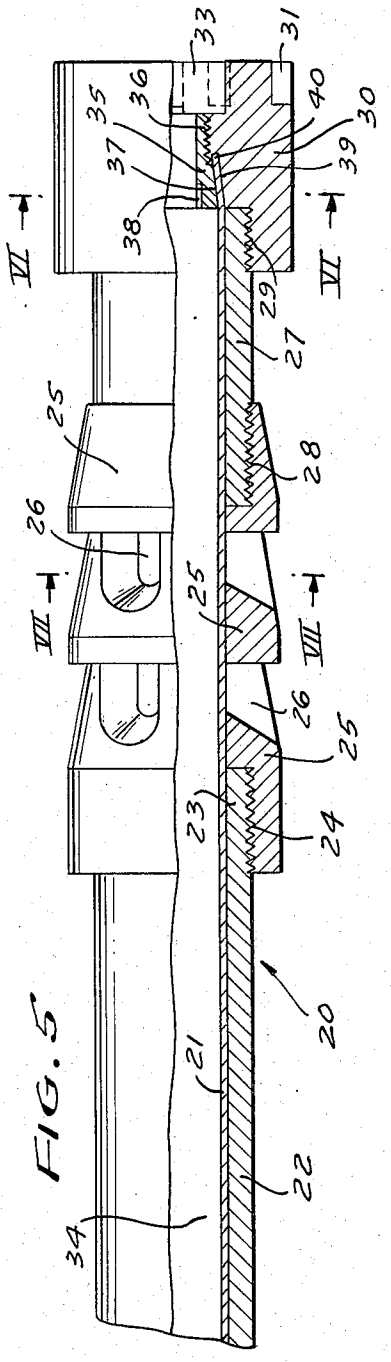


FIG. 5

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FIG. 9

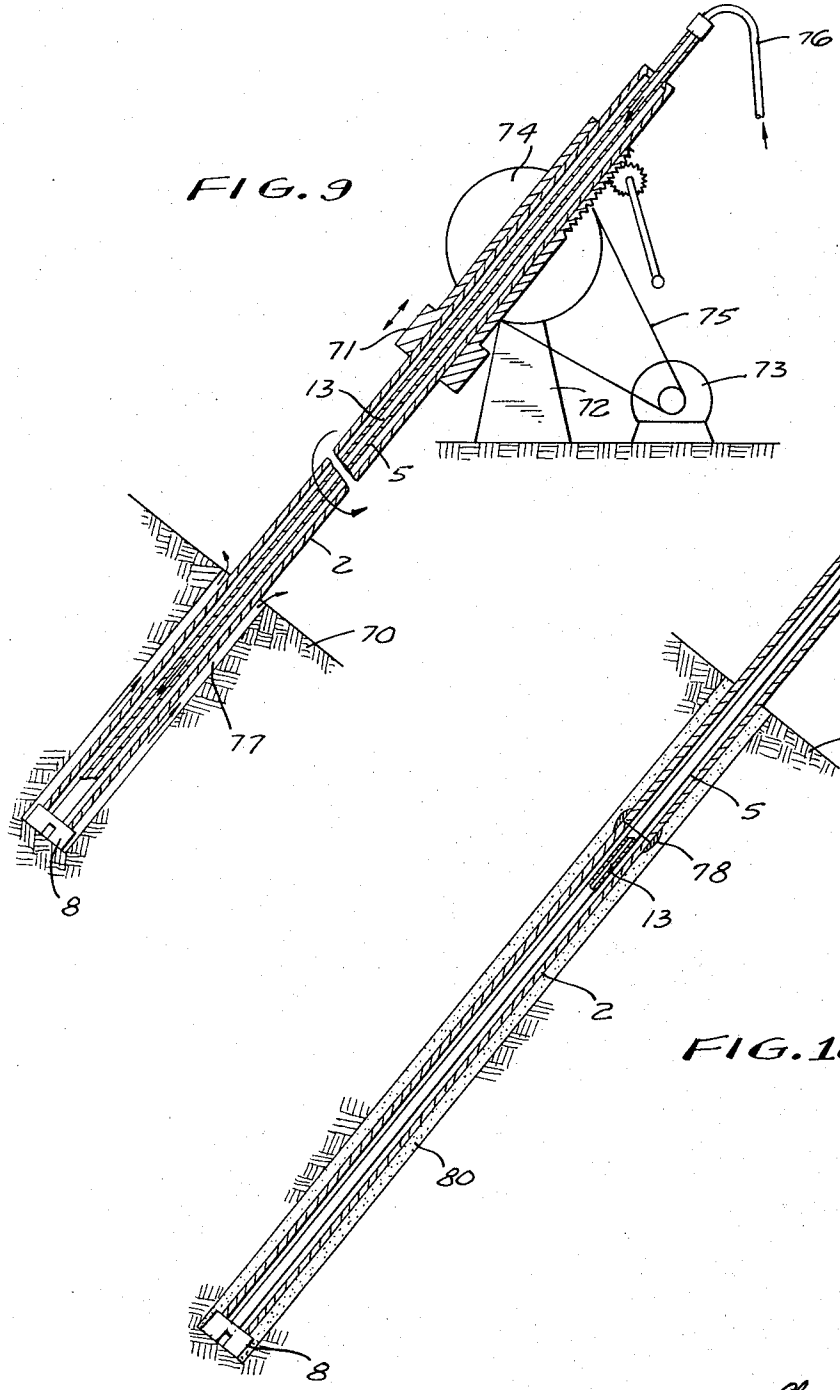


FIG. 10

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METHOD AND APPARATUS FOR SECURING ANCHORAGE IN LOOSE AND COMPACT GROUND

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FIG. 11

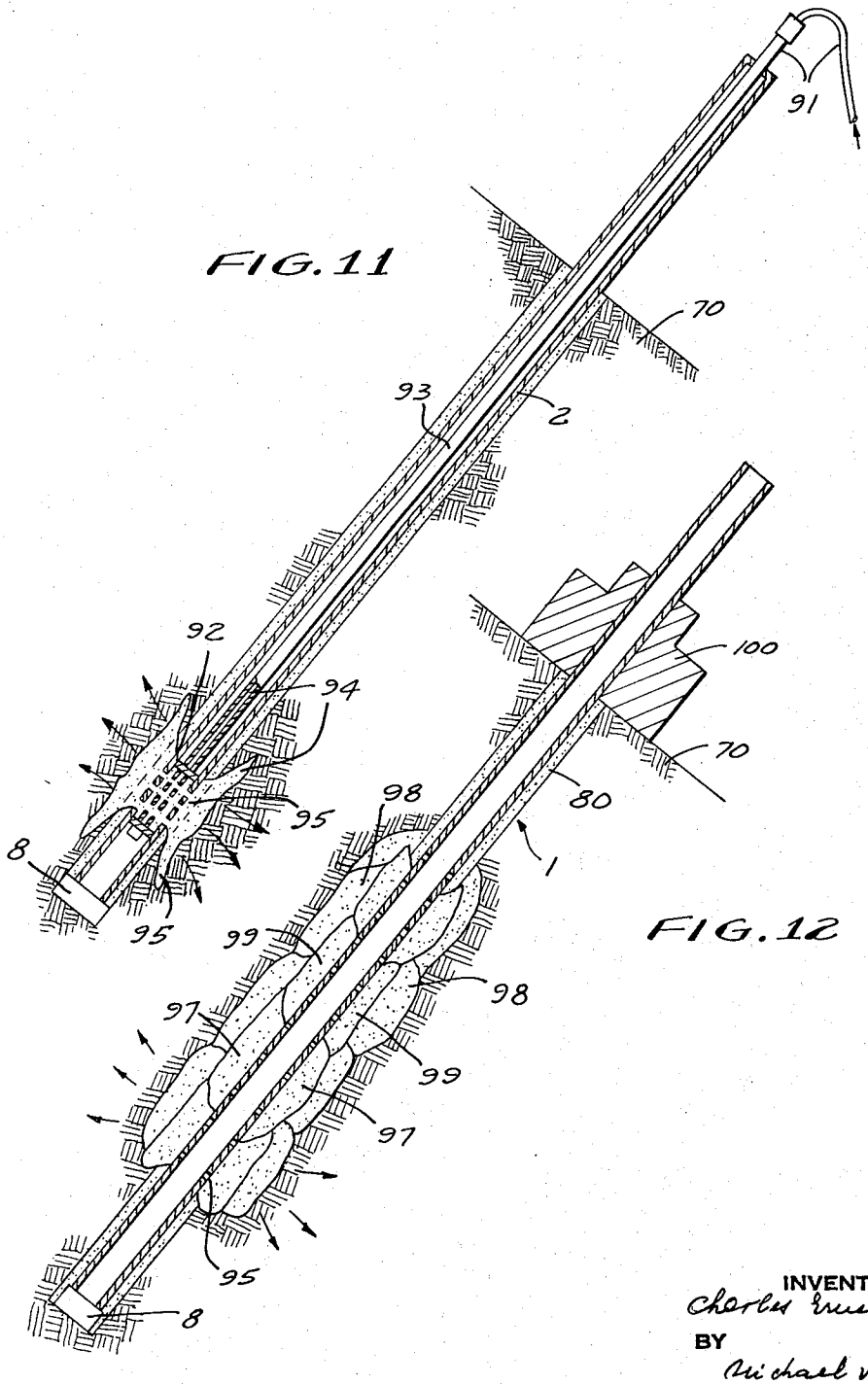


FIG. 12

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3,359,742

METHOD AND APPARATUS FOR SECURING ANCHORAGE IN LOOSE AND COMPACT GROUND

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Continuation of application Ser. No. 294,280, July 11, 1963. This application Sept. 13, 1966, Ser. No. 589,175
Claims priority, application Switzerland, July 30, 1962, 9,101/62
7 Claims. (Cl. 61—53.58)

This application is a continuation of Ser. No. 294,280, filed July 11, 1963, and now abandoned.

The instant invention relates to a method for securing or installing anchorages in loose, as well as compact, ground and also apparatus for practicing the method.

In the prior known methods, injection anchoring rods of either armor steel or bundles of steel wires, are inserted into holes in the ground which have previously been bored by drilling tools and pipe casings, and are cemented thereinto by injection of cement mortar or grout. For rammable substrata, a method in which anchor piles are rammed into the ground and are then enveloped and tightly held by the injection of mortar at a certain depth, is also known. Such anchoring piles are not appropriate for all types of substrata and hence are not utilizable in all instances.

The object of the instant invention is to provide a simple and inexpensive method for installing anchoring means in any type of ground whether of a looser or more compacted composition. The method of the instant invention is characterized in that a hollow anchor in the form of a rotative drilling tool is inserted into the earth by rotation drilling and is secured and held therein. The apparatus to practice the invention features an anchor in the form of a rotating boring tool or drill.

The invention is explained with reference to illustrative embodiments shown in the figures of the drawing, in which:

FIG. 1 is a longitudinal section through an illustrative anchor embodiment having an attached solid bit or reamer;

FIG. 2 is a section of the anchor of FIG. 1 on line II—II;

FIG. 3 is a section of the FIG. 1 anchor on line III—III thereof;

FIG. 4 is a front view of the anchor;

FIG. 5 is a view, partially in section, of another embodiment of the anchor of my invention;

FIG. 6 is a section through the solid bit or reamer of the anchor of FIG. 5 on line VI—VI;

FIG. 7 is a section through the injection rings of the anchor of FIG. 5 on line VII—VII;

FIG. 8 is a longitudinal section of another illustrative embodiment of the anchor of my invention with superposed full boring bit;

FIG. 9 is an axial section through a schematic showing of an anchor during the boring period with a schematic showing of the drive for rotary movement of the boring anchor;

FIG. 10 is a showing analogous to that of FIG. 9 after boring, with the anchor in its deepest position and with the filling mass injected thereinto;

FIG. 11 is a showing analogous to those of FIGS. 9 and 10 with the injection means inserted in the anchor and the initial step of the first injection process completed; and

FIG. 12 is a showing analogous to those of FIGS. 9 to 11 with a completely inserted and filled anchor readied

for its load, with two steps of each of two injected masses for holding the anchor securely in the ground surrounding it.

Anchor **1** for insertion into the earth, and known as an "injection tension anchor," has an anchor tube **2** having openings **3** and a plurality of reinforcing rings **4** about its exterior, the rings having conical shoulders facing the forward end of the anchor. Within anchor tube **2** a flushing or scavenging pipe **5** is affixed of which pipe end **6** is threaded as shown at **7**. A full or solid ring bit **8** with lateral attachment bores **9** is welded to the anchor tube **2** and by the attachment bores **9** in the manner shown at the collar thereof. The scavenging tube **5** is positioned in a central threaded bore **10** of the bit **8**. The central bore **13** of tube **5** opens into an eccentric scavenging bore **11** of the solid bit **8**, and, as shown in FIG. 4, the bit **8** is provided with prisms **12** of hard metal distributed over the front surface of the bit so that on rotation the ground is bored circularly.

Anchor tube **2** is in the form of a thick-walled steel tube normally of a length of some 25 to 30 feet. As required by the predetermined total length of the anchor, these anchor tubes are joined to each other either by welding their ends or by threaded coupling sleeves. Instead of the hard metal prism bit **8** shown in FIGS. 1, 2 and 4, a diamond bit may be used. Bit **8** forms an integral part of the anchor. It remains in the ground with it and cannot be recovered or retrieved. Opening **3** provided in the lower part of anchor tube **2** has as its purpose to permit the injected material to flow laterally therefrom while reinforcing rings **4** increase the adhesive strength of the anchor in order to produce a serrating of the injected mortar as below described in greater detail. The flushing or internal pipe **5**, which is screwed to the inner wall of bit **8** at its front end and, after the boring and injection of the fill are completed, is unscrewed and removed from the anchor, serves for introducing the flushing water while boring and for injecting the fill. The free end of the anchor is provided with threading **14** and serves for connecting it with the structural element to be anchored or as a connecting thread for the next anchor tube.

In a further embodiment shown in FIGS. 5 to 7 of an injection anchor **20**, a flushing tube **21** of plastic is enveloped by an anchor pipe **22** (FIG. 5). The tubular end **23** of anchor pipe **22** is an externally threaded tube **24** functioning as the connecting means of injection rings **25**. These rings have openings **26** corresponding to openings **3** of the first described illustrative embodiment. Cascade-shaped injection rings **25** are connected by threading **28** to an intermediate nipple **27** of which the free end serves the purpose, by means of threads **29**, of connecting a solid bit **30** to the anchor. On its front face this solid boring bit **30** has recesses **31** to provide for installing prisms **32** of hard metal. The bit is also provided with a flushing bore **33** eccentrically disposed relative to the axis of the anchor as an extension or continuation of a central bore **34** of the flushing pipe **21**. An insert nipple **35** provided with external threading is provided for screwing into the internal threading **36** of the boring bit **30**. Nipple **35** has a conical gripping surface **37** and, using a square key which fits into the square aperture **38** of the nipple **35**, this may be screwed into boring bit **30** provided with a conical bore **39**. Conical bore **39** and conical gripping surface **37** serve to clamp and tightly hold the conical end **40** of the inner tube as shown in FIG. 5.

This injection anchor **20** is likewise in the first phase of its use to be utilized as a boring tool drill mechanism which bores its own bore-hole and in which it is ultimately fastened in and to the ground. After the drilling

has been completed and the anchor has reached its requisite depth, a fill mass, for example in the form of mortar, is injected under pressure through the central bore **34** thereof which served for water flushing during drilling operation. Instead of mortar, an appropriate synthetic filling mass may be injected. Such filling mass rushes out of the front through the boring bit **30** and fills the space between the anchor and the walls of the drilled hole. Subsequently, the inserted nipple **35** can be loosened by means of the square key attached to the end of a long rod and introduced through the flushing tube **21** into the square aperture **38** of the nipple **35** so that the latter may be withdrawn with flushing tube **21**. Whereupon the anchor is ready to be affixed in and to the ground by means of the material injected thereinto by way of apertures **26** in predetermined manner.

In the modified embodiment of an injection anchor **50** shown in FIGURE 8, an anchor tube **51** is provided with elongated apertures **52** of which but one is shown. The far end **53** of anchor tube **51** is externally threaded **54** for attachment to the succeeding anchor tube section or to the structural element provided for anchoring. The end **55** of such tube is likewise externally threaded at **56**. A flushing pipe **57** is disposed axially within, and enveloped by, anchor tube **51**, its end **58** having internal threading **59** as also a conical gripping surface **60**. This flushing pipe **57** is connected to a nipple **61** whose end **62** is externally threaded **63** as is also its other end **64** at **65**, the latter connecting the nipple with a non-coring drilling bit **66**, as shown in FIGURE 8. The drilling bit **66** has prisms of hard metal **67** and is provided with an eccentric flush hole **68** which forms a continuation of flushing tube **57** and of nipple **61**. The boring bit **66** is connected by threading **56** with the anchor tube **51** of the injection anchor **50**. The mode of operation of this anchor, which likewise functions as a drill in its first phase with the drilling by means of non-coring bit **66** and its hard metal prisms **67**, is such that it remains in the ground as a tension anchor, and thereupon is fastened therein in the above described manner.

The attaching threads and threading of the described anchor structures are such that during the boring operation they do not loosen but, on the contrary, tighten.

With reference to FIGURES 9 to 12, the method of installing the above anchoring structures in both loose and compacted ground is shown phasewise. FIGURE 9 schematically shows the insertion of an injection tensil anchorage of my invention in the drilling phase during which the non-coring bit **8** bites into the ground **70** to produce the drilled bore for insertion of the tension anchor. Anchor **1** is fixed in a holding member **71** so that the anchor is driven by rotation and simultaneously axially advanced by a drilling machine **72**. An electric motor **73** by way of driving belt **75** rotates a flywheel **74** which transmits its rotary motion to anchor **1** by way of gearing, not shown. The drill advancing force is transmitted by the holding member **71** to anchor tube **2** which it engages, and thus the non-coring bit **8** and the hard metal prisms **12**. Depending on the length of injection tension anchor **1**, additional sections of anchor tube are attached to the first section **2** of the anchor tube, also increasing the length of flushing tube **5** so that a flushing water source **76** can be connected thereto. A stream of water **77** is forced through flushing pipe **5** during the drilling operation and leaves at the front through the central, but eccentric, flush port **11** of the non-coring bit **8** and, flowing out about the bit, carries with it the loosened earth which flows upwardly between the anchor pipe **2** and the walls of the drilled hole. The tension anchor serving as the drill is advanced in the ground in the stated manner.

In FIGURE 10 there is depicted that phase of the installation procedure in which the drilling has been completed and the anchor **1** has reached the predetermined depth in the ground. In accordance with the depth of the drilled hole, respectively, the required length of the injection tension anchor, the successive sections of the anchor tube **2**, are interconnected by coupling sleeves **78**, and the free end of the last in succession of the flushing pipe sections **5**, project beyond the last of the successive anchor tube sections **2** and serves as the element to which the fillng material injecting device is connected. By means of this device, a filling material, which usually is a cement mortar but may, inter alia, also be a synthetic material, is injected into the flushing tubing **5** and fills the interstices between anchor **1** and the walls of the drilled hole, as described. This initial forcing of the filling material through the flushing or inner piping **5** serves in the later phases to prevent the rising of the injected mass at the exterior of the anchor during subsequent injections. The injected mass is of such composition that on freezing, hardening or solidifying, it does so without any decrease in its volume and such that the solidified mass can be burst at a predetermned internal pressure applied thereto. After this initial injection, the inner or flushing tube **5** is unscrewed and pulled out, and the interior of the anchor tube **2** is cleansed by washing.

After the injected filling mass has sufficiently set and hardened, the anchor is cemented in by stepwise pressure grouting with cement mortar or other fastening material in the direction from bottom to top with the aid of the injecting mechanism **91** (FIGURE 11). This mechanism has an injecting piston or packer **92** and a supply line **93**. Between two sealing regions, packer **92** operates in a hollow region between such two sealed regions, in which hollow region the material to be injected, by way of appropriate apertures, is fed from supply line **93**. Relative to bores **3**, the injecting mechanism **91** so presses the injection material into anchor tube **2** that at the region of the desired injection, bores **3** are between the two packed regions of the hollow region of packer **92**. By forcing the injection mass through the injecting mechanism **91**, the injection mass flows through the supply line **93** and passes into the described hollow region, is forced therefrom through bores **3**, and, on reaching the predetermined pressure, bursts the filling material **80**. Through the channels **95** produced by such bursting, the injection mass is forced into the ground around the anchor. In FIGURE 11, the first stage of the first injection **94** is shown. The diameter of the injection packer **92** may be appropriately fitted to the internal diameter of anchor tube **2**. In that the inventive method permits of repeated injections at stepwise increased pressure, excellent anchoring in the ground is obtained. FIGURE 12 shows an anchor of the invention of which the embedding in the ground has been completed. As described above, a first injection mass **97** was pressed thereinto in the second phase and two further injections masses, **98** and **99**, in two additional phases. The number of injection or extrusion phases, and the pressures thereof, depend on the required resistance of the completely installed injection anchor. After the injected masses have hardened and solidified, the tension anchor of the invention is ready to be connected by the fastening element **100** to the structure provided therefore. Furthermore, there is the possibility of reinforcing the anchor tube by insertion thereinto of one or more additional tension rods or bunches of cables or wires of high strength and to connect such bunches with the anchor tube or boring bit by threaded couplings. It will be noted that such reinforcing members may be pretensioned in such manner that pretensioned anchors are formed. So also reinforcing members may be cast in the anchor tubes, in which event the interior surfaces of the anchor tubes are preferably provided with elements, for example irregularities therein, which improve the adhesion between the casting material and the anchor tubes.

The instant inventions have, inter alia, the following advantages over the prior art:

The installation of the tension anchor, consisting essentially of the steel tube, is accomplished by the tension anchor itself;

The installation (drilling) is possible by a rotary movement of the tension anchor;

The anchor tube serves as drill rod while drilling;

The tip of the anchor is a drill bit which remains in the ground;

For introducing water for flushing while drilling and for injecting a filling mass into the hollow region between the anchor tube and the ground, an inner tube is removably connected with the tension anchor;

The structure of the inventive tension anchor permits of repetitive and stepwise injection of the filling mass, with the composition of the filling mass and the pressure utilized for each injection adapted to the requirements to be met by each individual injection step;

The sinking of the anchor by rotary drilling can be done by using a common rotary drilling equipment;

The provision of lateral apertures in the anchor tube and the use of the sealed packer permit repetition of the injection in each section of the anchor any number of times, and the composition of the filling mass and the pressure under which it is to be injected, can be varied to meet requirements at each stage; and

Section after section of the required length of the anchor can be drilled into the ground and installed, and, as will be readily noted from the above description of the method, the grouting may be done in any amount for any required lengths, in any desired sequence, in any desired number of operations, and with any desired pressure.

The inventive injection anchor can be used in all types of soil and rock formations, that is, in cohesive and non-cohesive ground or earth including rock debris or moraine, as also in soynd or decomposed rock. It must be emphasized that even where ground water under pressure is present, the execution of the anchor is possible without difficulty. Also, my inventive method can be used for the sinking and construction of foundation piles. I mention as particularly useful fields of use, the anchoring of cutoff concrete walls, walls of piles, sheet pilings, bulkheads, etc., mine safety shafts, masts for carrying high tension lines, cable railways, cable lifts, cable cranes, etc., penstock foundations, harbour installations, quay walls, retaining walls, protection galleries, etc.

I claim:

1. A method of securing elongated tubular shaft means having at least one radial aperture intermediate its ends in a bore hole in the ground having a diameter greater than the outside diameter of the tubular shaft means, comprising the steps of injecting into the space between the outer surface of said shaft means and the inner surface of said bore hole a first flowable and hardenable material, adapted to fracture in its hardened condition at a predetermined pressure, to substantially fill said space; permitting said material to harden so as to form a mantel of hardened material about said shaft means; subsequently injecting through said tubular shaft means and said aperture therein additional hardenable material at a pressure at least equal to said predetermined pressure to fracture said mantel of hardened material and to cause said additional material to pass through the fractures into the ground surrounding said mantel while filling said fractures; and permitting said additional material to harden in said fractures and about said mantel of hardenable material.

2. A method as set forth in claim 1, wherein said first injected hardenable material is a material which hardens substantially without shrinking.

3. A method as set forth in claim 1, wherein said tubular shaft means is provided with a plurality of radial apertures axially spaced from each other, and wherein said additional material is injected in successive steps through said axially spaced apertures, respectively, starting with the lowest one of said apertures.

4. A method as set forth in claim 3, wherein said successive injections of said additional material are respectively carried out at different pressures.

5. A method as set forth in claim 1, wherein said first material is injected centrally through said tubular shaft means to pass through the bottom end of the latter into said space.

6. A method as set forth in claim 1, wherein said tubular shaft means include a drill bit at the bottom end thereof, and including the step of boring said bore hole by means of said drill bit on said shaft means.

7. Combined tubular drill and anchor means comprising, in combination, elongated tubular shaft means including at least one elongated tube having an open bottom end and being formed in the wall thereof with at least one radial aperture upwardly spaced from said bottom end, and a drill bit fixed to said bottom end and formed with a flushing opening therethrough; and a flushing pipe extending axially through said tubular shaft means and having a bottom end removably connected to said elongated tube in the region of the bottom end of the latter and communicating with said flushing opening through said drill bit, whereby after boring of the bore hole in the ground by means of said combined drill and anchor means a first hardenable material may be injected through said flushing tube and said flushing opening in said drill bit to rise in said bore hole about said tubular shaft means to form after hardening a mantel of hardened material about said shaft means, and after removal of said flushing tube a second hardenable material may be injected through said tubular shaft means and said aperture with a pressure sufficient to fracture said mantel so that said second material may pass through the fractures into the ground.

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JACOB SHAPIRO, *Primary Examiner.*

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,359,742 December 26, 1967

Charles Ernst Blatter

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

In the heading to the printed specification, line 10, for "589,175" read -- 579,175 --.

Signed and sealed this 4th day of February 1969.

(SEAL)
Attest:

Edward M. Fletcher, Jr.
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents