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955031

THE UNITED STATES OF AMERICA

TO ALL TO WHOM THESE PRESENTS SHALL COME:

UNITED STATES DEPARTMENT OF COMMERCE

United States Patent and Trademark Office

October 21, 2018

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APPLICATION NUMBER: 62/568,948

FILING DATE: *October 06, 2017*

RELATED PCT APPLICATION NUMBER: *PCT/US18/54384*

THE COUNTRY CODE AND NUMBER OF YOUR PRIORITY APPLICATION, TO BE USED FOR FILING ABROAD UNDER THE PARIS CONVENTION, IS *US62/568,948*



Certified by

Michelle K. Lee

Under Secretary of Commerce
for Intellectual Property
and Director of the United States
Patent and Trademark Office

Provisional Application for Patent Cover Sheet

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c)

Inventor(s)

Inventor 1

Remove

Given Name

Middle Name

Family Name

City

State

Country i

David

J.

White

Northfield

MN

US

All Inventors Must Be Listed – Additional Inventor Information blocks may be generated within this form by selecting the **Add** button.

Add

Title of Invention

Methods and Apparatus for Building Cemented Ground Support Columns

Attorney Docket Number (if applicable)

059288-00001

Correspondence Address

Direct all correspondence to (select one):

☒ The address corresponding to Customer Number

☐ Firm or Individual Name

Customer Number

128764

The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.

☒ No.

Yes, the invention was made by an agency of the United States Government. The U.S. Government agency name is:

Yes, the invention was under a contract with an agency of the United States Government. The name of the U.S. Government agency and Government contract number are:

Entity Status**Applicant asserts small entity status under 37 CFR 1.27 or applicant certifies micro entity status under 37 CFR 1.29**

- ☒ Applicant asserts small entity status under 37 CFR 1.27
- ☐ Applicant certifies micro entity status under 37 CFR 1.29. Applicant must attach form PTO/SB/15A or B or equivalent.
- ☐ No

Warning

Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.

Signature

Please see 37 CFR 1.4(d) for the form of the signature.

Signature	E. Eric Mills/		Date (YYYY-MM-DD)	2017-10-06	
First Name	E. Eric	Last Name	Mills	Registration Number (If appropriate)	47795

This collection of information is required by 37 CFR 1.51. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 8 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **This form can only be used when in conjunction with EFS-Web. If this form is mailed to the USPTO, it may cause delays in handling the provisional application.**

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that : (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	059288-00001
		Application Number	
Title of Invention	Methods and Apparatus for Building Cemented Ground Support Columns		
The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76. This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.			

Secrecy Order 37 CFR 5.2:

☐	Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)
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Inventor Information:

Inventor	1				Remove	
Legal Name						
Prefix	Given Name	Middle Name	Family Name	Suffix		
	David	J.	White			
Residence Information (Select One) • ☒ US Residency ☐ Non US Residency ☐ Active US Military Service						
City	Northfield	State/Province	MN	Country of Residence	US	
Mailing Address of Inventor:						
Address 1	c/o Ingios Geotechnics, Inc.					
Address 2	P.O. Box 101					
City	Northfield	State/Province	MN			
Postal Code	55057	Country	US			
All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the Add button.						Add

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below. For further information see 37 CFR 1.33(a).			
☐ An Address is being provided for the correspondence information of this application.			
Customer Number	128764		
Email Address	USPatent@nexsenpruet.com	Add Email	Remove Email

Application Information:

Title of the Invention	Methods and Apparatus for Building Cemented Ground Support Columns		
Attorney Docket Number	059288-00001	Small Entity Status Claimed	☒
Application Type	Provisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	5	Suggested Figure for Publication (if any)	1

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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	059288-00001
		Application Number	
Title of Invention	Methods and Apparatus for Building Cemented Ground Support Columns		

Filing By Reference:

Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY-MM-DD)	Intellectual Property Authority or Country

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not be** the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32). Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.

Please Select One:	☒ Customer Number	☐ US Patent Practitioner	☐ Limited Recognition (37 CFR 11.9)
Customer Number	128764		

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, 365(c), or 386(c) or indicate National Stage entry from a PCT application. Providing benefit claim information in the Application Data Sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.

When referring to the current application, please leave the "Application Number" field blank.

Prior Application Status		Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the Add button.			Add

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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	059288-00001
		Application Number	
Title of Invention	Methods and Apparatus for Building Cemented Ground Support Columns		

Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55. When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX)ⁱ the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(i)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

Application Number	Country ⁱ	Filing Date (YYYY-MM-DD)	Access Code ⁱ (if applicable)	Remove

Additional Foreign Priority Data may be generated within this form by selecting the **Add** button.

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013. NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	059288-00001
		Application Number	
Title of Invention	Methods and Apparatus for Building Cemented Ground Support Columns		

Authorization or Opt-Out of Authorization to Permit Access:

When this Application Data Sheet is properly signed and filed with the application, applicant has provided written authority to permit a participating foreign intellectual property (IP) office access to the instant application-as-filed (see paragraph A in subsection 1 below) and the European Patent Office (EPO) access to any search results from the instant application (see paragraph B in subsection 1 below).

Should applicant choose not to provide an authorization identified in subsection 1 below, applicant **must opt-out** of the authorization by checking the corresponding box A or B or both in subsection 2 below.

NOTE: This section of the Application Data Sheet is **ONLY** reviewed and processed with the **INITIAL** filing of an application. After the initial filing of an application, an Application Data Sheet cannot be used to provide or rescind authorization for access by a foreign IP office(s). Instead, Form PTO/SB/39 or PTO/SB/69 must be used as appropriate.

1. Authorization to Permit Access by a Foreign Intellectual Property Office(s)

A. Priority Document Exchange (PDX) - Unless box A in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the State Intellectual Property Office of the People's Republic of China (SIPO), the World Intellectual Property Organization (WIPO), and any other foreign intellectual property office participating with the USPTO in a bilateral or multilateral priority document exchange agreement in which a foreign application claiming priority to the instant patent application is filed, access to: (1) the instant patent application-as-filed and its related bibliographic data, (2) any foreign or domestic application to which priority or benefit is claimed by the instant application and its related bibliographic data, and (3) the date of filing of this Authorization. See 37 CFR 1.14(h)(1).

B. Search Results from U.S. Application to EPO - Unless box B in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the EPO access to the bibliographic data and search results from the instant patent application when a European patent application claiming priority to the instant patent application is filed. See 37 CFR 1.14(h)(2).

The applicant is reminded that the EPO's Rule 141(1) EPC (European Patent Convention) requires applicants to submit a copy of search results from the instant application without delay in a European patent application that claims priority to the instant application.

2. Opt-Out of Authorizations to Permit Access by a Foreign Intellectual Property Office(s)

☐ A. Applicant **DOES NOT** authorize the USPTO to permit a participating foreign IP office access to the instant application-as-filed. If this box is checked, the USPTO will not be providing a participating foreign IP office with any documents and information identified in subsection 1A above.

☐ B. Applicant **DOES NOT** authorize the USPTO to transmit to the EPO any search results from the instant patent application. If this box is checked, the USPTO will not be providing the EPO with search results from the instant application.

NOTE: Once the application has published or is otherwise publicly available, the USPTO may provide access to the application in accordance with 37 CFR 1.14.

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	059288-00001
		Application Number	
Title of Invention	Methods and Apparatus for Building Cemented Ground Support Columns		

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Applicant	1	Remove
If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section. Clear		
Assignee	Legal Representative under 35 U.S.C. 117	Joint Inventor
☒ Person to whom the inventor is obligated to assign.		☐ Person who shows sufficient proprietary interest
If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:		
Name of the Deceased or Legally Incapacitated Inventor:		
If the Applicant is an Organization check here. ☒		
Organization Name	Ingios Geotechnics, Inc.	
Mailing Address Information For Applicant:		
Address 1	P.O. Box 101	
Address 2		
City	Northfield	State/Province
Country	US	Postal Code
Phone Number		Fax Number
Email Address		
Additional Applicant Data may be generated within this form by selecting the Add button. Add		

Assignee Information including Non-Applicant Assignee Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	059288-00001
		Application Number	
Title of Invention	Methods and Apparatus for Building Cemented Ground Support Columns		

Assignee	1		
Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication. An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.			
			Remove
If the Assignee or Non-Applicant Assignee is an Organization check here.			☒
Organization Name	Ingios Geotechnics, Inc.		
Mailing Address Information For Assignee including Non-Applicant Assignee:			
Address 1	P.O. Box 101		
Address 2			
City	Northfield	State/Province	MN
Country i	US	Postal Code	55057
Phone Number		Fax Number	
Email Address			
Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button.			Add

Signature:[Remove](#)

NOTE: This Application Data Sheet must be signed in accordance with 37 CFR 1.33(b). **However, if this Application Data Sheet is submitted with the INITIAL filing of the application and either box A or B is not checked in subsection 2 of the "Authorization or Opt-Out of Authorization to Permit Access" section, then this form must also be signed in accordance with 37 CFR 1.14(c).**

This Application Data Sheet **must** be signed by a patent practitioner if one or more of the applicants is a **juristic entity** (e.g., corporation or association). If the applicant is two or more joint inventors, this form must be signed by a patent practitioner, **all** joint inventors who are the applicant, or one or more joint inventor-applicants who have been given power of attorney (e.g., see USPTO Form PTO/AIA/81) on behalf of **all** joint inventor-applicants.

See 37 CFR 1.4(d) for the manner of making signatures and certifications.

Signature	/E. Eric Mills/		Date (YYYY-MM-DD)	2017-10-06
First Name	E. Eric	Last Name	Mills	Registration Number
Additional Signature may be generated within this form by selecting the Add button.				Add

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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	059288-00001
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Title of Invention	Methods and Apparatus for Building Cemented Ground Support Columns		

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Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

METHODS AND APPARATUS FOR BUILDING CEMENTED
GROUND SUPPORT COLUMNS

Inventor(s): David J. White (Northfield, MN)

Applicant: Ingios Geotechnics, Inc.

BACKGROUND OF THE INVENTION

Technical Field

The subject matter disclosed herein relates to the efficient construction of ground support columns used to provide support for and control settlements below building foundations, retaining walls, floor slabs, industrial facilities and the like. The present subject matter provides a method and apparatus that may be used to efficiently construct cemented piers with low and high mobility infill materials in soft ground conditions. The present subject matter further provides for a method and apparatus that allows for the effective placement and compaction of infill materials strengthened by fibers.

Background Art

Deep foundations have been used for centuries to support bridges, buildings, and other heavy structures on soft ground. Historically, deep foundations consisted of timber pilings driven into the ground using drop hammers. In more modern times, timber piles have been replaced with driven precast concrete pilings or steel pilings that offer a longer useable life and higher support capacities. Cast-in-drilled-hole concrete piers (also known as “drilled piers”, “drilled caissons” or “drilled shafts”) have been used for over a hundred years to provide support for heavy loads with application for highway bridge supports. These piers may be constructed in dry holes or may be constructed in holes drilled below the ground water level provided that temporary stabilization measures such as casings or drilling fluids are used in construction. Cast-in-drilled hole pilings are advantageous because they have high support capacities but have the drawback that they are difficult to construct particularly when the designer wishes to have a higher-end bearing surface than afforded by the drilling tool. Although auger belling tools, that rake outward and expand the bottom of the pier to a cross sectional area larger than

the shaft of the pier, are implemented at many sites with dry soil conditions or with stiff low-permeability cohesive soils, the construction of such piers in soft ground conditions or in granular and collapsible materials is difficult and may lead to construction deficiencies. At dry soil sites or at sites with subsurface materials consisting mainly of stiff low-permeability clay soils, bellings tools are used within cast-in-drilled-hole installations to expand the cross-sectional area at the bottom of the pier. In soft ground conditions or in granular soils, however, these tools can lead to ground loss and failure unless the subsurface materials are stabilized with drilling fluids that require extensive skill to employ. What is needed is a method that robustly allows for the construction of piers with differing diameters in many applicable soil conditions.

Auger-cast piles have been used in the United States since the 1950's and are installed by drilling continuous-flight augers into the ground and extracting the augers while backfilling the cavities with fluid grout. Auger cast piles may be constructed relatively quickly but have the disadvantage that the piles may have quality control issues with "necking" (reduced pile cross section) during auger extraction. Further, auger-cast pilings can only be constructed with one nearly-uniform diameter. Controlled Modulus Columns are a method described in US Patent No. 6,672,015 and consist of inserting a reverse-diameter displacement auger into the ground, which has the advantage that it produces little cuttings, and backfilling the cavities with cementitious ground during extraction. These elements develop little cuttings at the ground surface because of the reverse auger rotation but have the same disadvantages as described above for auger-cast pilings.

Other ground improvement methods currently exist in the field including the tamper head driven mandrel with restrictor elements (US Patent No. 7,604,437) that is used primarily for the placement of aggregate in the ground for ground improvement applications. This method offers the advantage that the restrictor elements may be used to prevent upward flow of the aggregate in the mandrel, a feature that facilitates the construction of expanded bulbs of aggregate during downward driving through the placed stone. As further described in US Patent No. 9,637,882 the restrictor elements may further be applied to the construction of below-grade low-slump concrete elements whereby the restrictor elements are used to create a bottom bulb but would not be applicable to cementitious sand-cement grouted elements because the lack of coarse aggregate precludes the development of the upward flow restrictors during driving.

Concrete ground improvement elements may also be constructed below grade and the bottom bulb may be expanded using the system described within US Patent No. 9,637,882 provided that the concrete infill materials contain sufficient amounts of coarse aggregate and are applied at using a sufficiently low slump to allow the restrictor elements to engage the concrete. This system cannot be effectively used, however, with fluid-like infill materials such as sand-cement grout and sand-polymer grout mixtures that are much easier to pump but do not contain sufficient coarse aggregate or a low enough slump for the restrictor elements to bind with the material.

What is needed is a method that can be used to create below-grade bottom bulbs within piers constructed from cemented infill materials with or without strengthening fiber additives. What is further needed is a means of constructing high-capacity cast-in-situ concrete pilings with high confidence quality control and the ability of constructing piers with differing base and shaft diameters.

GENERAL DESCRIPTION

The present subject matter provides a method for the efficient construction of cementitious ground reinforcement elements that may be installed with a high degree of construction confidence to provide variable diameters along the base and shafts of the elements. This method is particularly effective because it allows engineers and contractors with a means to optimize the shaft bearing capacity and the geotechnical support capacity for the same element, an advantage not shared by piers or shafts with uniform cross-sections.

The present subject matter provides an improved method and apparatus for constructing cementitious piers. In one embodiment, the method contains a specially designed flexible egress port connecting the main body (feed tube) of the driving mandrel with the mandrel compaction head. The flexible egress port has the advantage that it allows for smooth flow of relatively mobile cementitious aggregate materials downward as the tube is filled and then as the tube is lifted upwards. The smooth flow of material is advantageous because it allows for relatively rapid pier construction by facilitating rapid filling of the cavity made by the driving mandrel.

In previous art, the downward driving and compaction, the cementitious materials are compressed within the compaction head causing a tendency for the materials to move upwards in the compaction head and back through a rigid egress to decrease the effectiveness of downward compaction. The use of the flexible egress tube of the present subject matter, however, retards and

restrains upward movements of the cementitious materials because the flexible feed tube bends and crimps, thus preventing upward flow. The prevention of the upward flow allows the compaction chamber to push the cementitious materials downward into the cavity below, thereby effectively resulting in an expanded bulb. The expanded bulb may be constructed at any elevation along the pier, allowing for the construction of larger piers in soft ground conditions and allowing for the efficient construction of bottom bulbs using materials with variable mobilities. The purpose of the invention is to provide for a method of pier construction that allows high slump concrete and sand-cement/polymer grout mixtures to be placed and expanded below grade with a high degree of precision and confidence.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows one embodiment of the present subject matter for the efficient construction of piers.

Figure 2 shows a second embodiment of the present subject matter for the efficient construction of piers.

Figure 3 show the sequence of construction using one embodiment of the present subject matter.

Figure 4 shows the sequence of construction using a second embodiment of the present subject matter.

Figure 5 shows a closer view of the flexible egress port as it is being crimped during re-driving according to the present subject matter.

DETAILED DESCRIPTION AND EXAMPLES

Figure 1 shows one embodiment of the present subject matter for the efficient construction of piers. As shown in Figure 1, this embodiment consists of a driving mandrel (1) comprised of a top element (10), a feed tube (20), and a tamper head (30). In this embodiment, the top element (10) is configured with an open upper end (111) and an optional inlet injection port (12). The feed tube (20) is typically comprised of a cylindrical steel pipe with an inside diameter (21), and an outside diameter (22). Other feed tube cross-sectional geometries such as square, hexagonal, octagonal, and other articulated geometries are contemplated. The tamper head (30) contains an internal connection ring (31) and a flexible egress port (32) that is affixed to the internal connection ring (31). The flexible

egress port (32) may consist of flexible cylindrical material such as concrete hose, aramid fiber tubing, or other flexible tubular materials. The flexible egress port (32) is affixed at the top to the internal ring (31) and is configured to extend into the compaction chamber (33) that contains an internal diameter (34) and an external diameter (35).

Figure 2 shows a second embodiment of the present subject matter for the efficient construction of piers. As shown in Figure 2, this embodiment consists of a driving mandrel (1) comprised of a top element (21), a feed tube (20), and a tamper head (30). The top element (21) is configured with a closed upper end or lid (11), an inlet injection port (12), an optional pressure gage (13), and an optional pressure relief valve (14). The feed tube (20) is typically comprised of a cylindrical steel pipe with an inside diameter (21), and an outside diameter (22). Other feed tube cross-sectional geometries such as square, hexagonal, octagonal, and other articulated geometries are contemplated. The tamper head (30) contains an internal connection ring (31) and a flexible egress port (32) that is affixed to the internal connection ring (31). The flexible egress port (32) may consist of flexible cylindrical material such as concrete hose, Kevlar tubing, or other flexible tubular materials. The flexible egress port (32) is affixed at the top to the internal ring (31) and is configured to extend into the compaction chamber (33) that contains an internal diameter (34) and an external diameter (35). The compaction chamber contains an open lower surface (36) for placement of cementitious material in the created cavity.

Figure 3 shows the method of construction using the first embodiment and the apparatus shown in Figure 1.

Figure 3A shows the apparatus described in Figure 1 prior to being driven in to the ground.

Figure 3B shows the apparatus described in Figure 1 when it is partially driven into the ground to a prescribed initial driving depth (51) using a conventional piling rig and hammer (40). The mandrel is driven to the prescribed driving depth and the cementitious backfill is optionally added to the mandrel by pumping into the open upper end of the mandrel (111) or into the optional inlet port (12).

As shown in Figure 3B, when the apparatus is driven to the initial driving depth (51) the remainder of the required infill material, such as cementitious grout (60), is then pumped into the apparatus (1) through the optional injection port (12) or through the open upper end (111). Cementitious infill materials that are placed within the feed tube are designed with sufficient mobility (fluidity) so that they are easier to mix and pump and flow unimpeded downward through the feed tube and through the bottom flexible egress port (32). Typical cementitious infill materials designed for this

purpose may include mobile (medium to high slump) concrete, sand-cement grout, or neat cement grout.

Figure 3C shows the apparatus (1) as it is further driven to the prescribed driving termination depth (52).

Figure 3D shows that after the apparatus is driven to the prescribed driving depth, the apparatus is then raised and the infill material exits through the flexible egress port (32), into the compaction chamber (33). The infill material exits the egress port (32) by gravity, into the compaction chamber (33), and further into the annular space created at the bottom of the apparatus as is it lifted to the lift height (53) to form placed cementitious material (62). Cementitious infill material easily flows during this installation step because the flexible egress port (32) extends downwards without any constrictions into the compaction chamber (33).

Figure 3E shows the construction of a bottom expansion element whereby the apparatus is re-driven back downwards into the placed cementitious material (62). As the apparatus is re-driven downwards the infill material in the compaction chamber (32) attempts to move upwards and attempts to flow back into the feed tube (20). As the cementitious material attempts to flow back into the flexible egress port, the flexible egress port (32) constricts and crimps as the result of the upward movement of the infill material as it attempts to flow back upward into the egress port (32). As shown in Figure 5, the crimping of the flexible egress port (32) prevents backflow into the feed tube (20) thus allowing the compaction chamber to compact the extruded infill material (62) and expand the infill material to form an enlarged bulb at the bottom of the mandrel apparatus (63). This enlarged bulb (63) may be constructed at the bottom of the pier to facilitate load transfer to the underling foundation materials or may be constructed at any elevation along the shaft of the constructed pier to create an enlarged cross sectional area in either weak soil materials or to facilitate additional side shearing resistance that is enacted during structural loading.

Figure 3F shows the apparatus as it is then lifted upward allowing for the infill material to flow downward through the egress port and through the compaction chamber (33) to form the shaft of the pier.

Figure 4 shows the method of construction using the second embodiment and the apparatus shown in Figure 2.

Figure 4A shows the apparatus described in Figure 2 prior to being driven in to the ground.

Figure 4B shows the apparatus described in Figure 2 when it is partially driven into the ground to a prescribed initial driving depth (51) using a conventional piling rig and hammer (40).

As shown in Figure 4B, when the apparatus is driven to the initial driving depth (51) infill material, such as cementitious grout (60), is then pumped into the apparatus (1) through the injection port (12). In this second embodiment, the driving mandrel (1) contains a closed top lid (11) that is welded to the feed tube (20). For this embodiment, as the infill material enters the apparatus (1), the air that is initially contained within the apparatus is compressed because the apparatus is closed at the bottom by the presence of soil surrounding the bottom of the apparatus and by the closed lid (11) at the top of the apparatus. This causes the air pressure in the apparatus to increase as measured by the air pressure gage (13). Should the air pressure exceed the allowable air pressure within the apparatus, the air pressure relief valve (14) releases the overpressure into the atmosphere.

Figure 4C shows the apparatus (1) as it is further driven to the prescribed driving termination depth (52).

Figure 4D shows that after the apparatus is driven to the prescribed driving depth, the apparatus is then raised and the infill material exits through the egress port (32), into the compaction head (20) as placed cementitious material (62). In this second embodiment containing a closed top lid (11), the air pressure within the feed tube (20) of the apparatus extrudes the cementitious material (62) out into the annular space created at the bottom of the apparatus as is it lifted to the lift height (53). Cementitious infill material is easily extruded during this installation step because the flexible egress port (32) extends downwards without any constrictions into the compaction chamber (33). In this second embodiment, either low-mobility or high-mobility cementitious backfill materials may be used.

Figure 4E shows the construction of the bottom expansion element whereby the apparatus is re-driven back downwards into the placed extruded concrete (62). As the apparatus is re-driven downwards the infill material in the compaction chamber (30) moves upwards and attempts to flow back into the feed tube (20). When this occurs, the flexible egress port (32) constricts and crimps as the result of the upward movement of the infill material as it attempts to flow back upward into the egress port (32). As shown in Figure 5, the crimping (41) of the flexible egress port (32) prevents backflow into the feed tube (20) thus allowing the compaction chamber to compact the extruded infill material (62) and expand the infill material to form an enlarged bulb (63) at the bottom of the mandrel. As noted for the first embodiment, in this second embodiment the enlarged bottom bulb (63) may be constructed

at the bottom of the pier to increase the load transfer to a firm layer or may be constructed at any elevation along the pier to expand the pier into soft soil materials to or to increase load transfer through side shear.

Figure 4F shows the apparatus as it is then lifted upward allowing for the infill material to flow downward through the egress port and through the compaction chamber (33) to form the shaft of the pier.

It is well known by those skilled in the art that the formation of cementitious elements below grade is fraught with difficulty and that the formation of support piers with different cross-sectional dimensions is difficult at best. As shown in Figure 1, 2 and 5, the present subject matter provides for the insertion of a flexible hose egress port (32) that extends from the bottom of the feed tube into the compaction chamber. The egress port should be large enough in area to provide for efficient through flow but small enough in cross-sectional area to facilitate crimping and bending of the hose during downward mandrel movements. The hose is connected to the feed tube at the top of the hose using a variety of different connection details. The egress port (32) extends downward into the compaction chamber (33) to a sufficient length to allow for hose crimping and bending during downward mandrel movements. The egress port materials may consist of many differing grades, strengths, and thicknesses, each containing its own advantages and disadvantages with respect to flowability, crimpability, mobility, bendability, durability, and longevity. The egress port can be oriented vertically at the center of the feed tube or positioned at one side of the feed tube offset from center. The flexible egress tube can be positioned vertical or horizontally. The egress port hose may vary in diameter from 1 inch to the inside dimension of the feed tube and generally less than 36 inches. The required length of the egress port as it extends into the compaction chamber (33) depends on the characteristics of the infill material placed, requirements for flow, the diameter of the egress port and other factors. The port length (L) to port diameter (d) ratio (L/d) generally ranges from 1 to 20 with most applications ranging between 2 and 3.

Figures 1 and 3 shows a first embodiment of the present subject matter whereby the apparatus (1) is manufactured using an open upper end (111). An open upper end may consist of a simple opening at the top of the mandrel or an open port extending into a hopper connected to the top of the mandrel. In this embodiment, cementitious infill material may be added through the optional inlet port (12) or through the top of the mandrel feed tube and allowed to flow by gravity through the mandrel. If

concrete is used as infill material, the concrete slump may vary widely with higher slump mixtures corresponding to enhanced mobility, pumpability, and enhanced mandrel flow. Similarly, sand-cement grout mixtures, which provide for relatively easy pumping and flow, may also be used. As shown in Figure 3, the gravity-fed infill materials flow downward through the mandrel feed tube (20) and through the egress port (32) as the mandrel is initially driven downward (Figure 3B) and then lifted (Figure 3D). During downward re-driving (Figure 3E), the material in the compaction chamber (33) is pushed upwards against the flexible egress port (32). This causes the port to crimp (41) and bend as shown in Figure 5. Thus the egress port acts as an effective valve preventing the upward movement of high-mobility cementitious materials into the feed tube, even if the feed tube provides for gravity, not pressurized, flow. The apparatus and method of the first embodiment have the advantage that the mandrel design is simpler to construct.

Figures 2 and 4 show a second embodiment of the present subject matter whereby the apparatus (1) is manufactured using a closed upper end (11). In this embodiment, cementitious infill material is pumped through the inlet port (12). If concrete is used as infill material, the concrete slump may vary widely with higher slump mixtures corresponding to enhanced mobility, pumpability, and enhanced mandrel flow. Similarly, sand-cement grout mixtures, which provide for relatively easy pumping and flow, may also be used. As shown in Figure 4, the gravity-fed infill materials flow downward through the mandrel feed tube (20) and through the egress port (32) as the mandrel is initially driven downward (Figure 4B) and then lifted (Figure 4D). During downward re-driving (Figure 4E) the material in the compaction chamber (33) is pushed upwards against the flexible egress port. This causes the port to crimp and bend as shown in Figure 5. Thus, the egress port acts as an effective valve preventing the upward movement of high-mobility cementitious materials into the feed tube, even if the feed tube provides for gravity, not pressurized, flow. The apparatus and method of the second embodiment have the advantage that a wide variety of cementitious mix designs may be used for installation.

The foregoing detailed description of embodiments refers to the accompanying drawings, which illustrate specific embodiments of the present subject matter. Other embodiments having different structures and operations do not depart from the scope of the present subject matter. The term "the invention" or the like is used with reference to certain specific examples of the many alternative aspects or embodiments of the applicant's invention set forth in this specification, and neither its use nor its absence is intended to limit the scope of the applicants' invention or the scope of the claims. This

specification is divided into sections for the convenience of the reader only. Headings should not be construed as limiting of the scope of the invention. The definitions are intended as a part of the description of the invention. It will be understood that various details of the present invention may be changed without departing from the scope of the present subject matter.

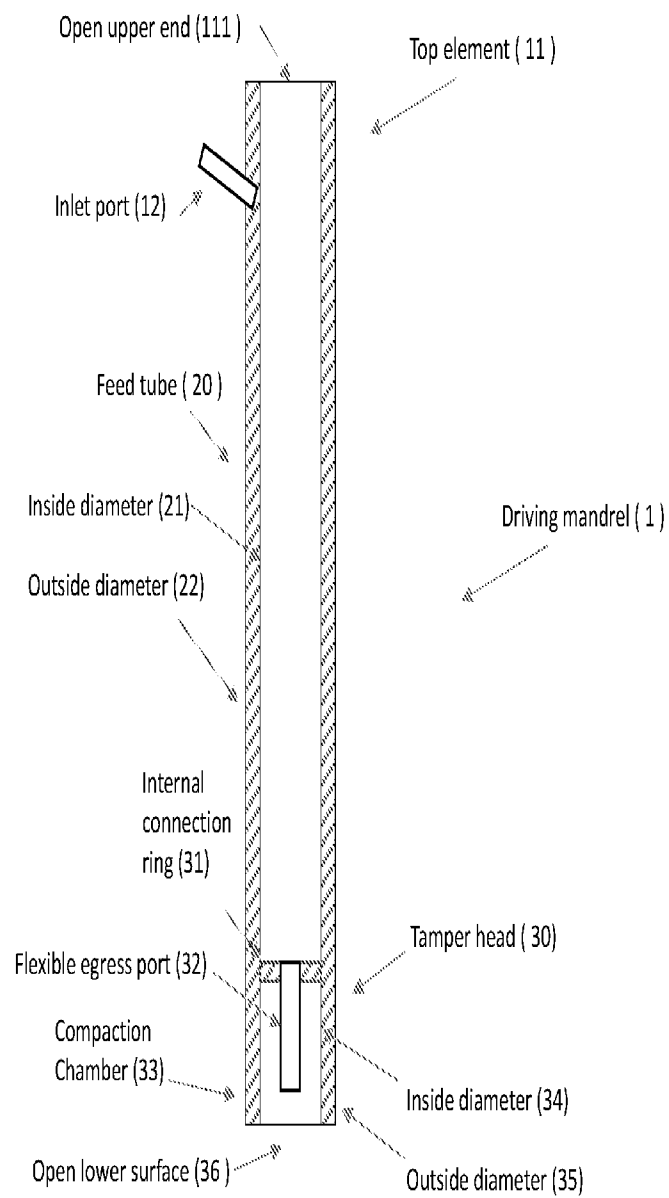


Figure 1

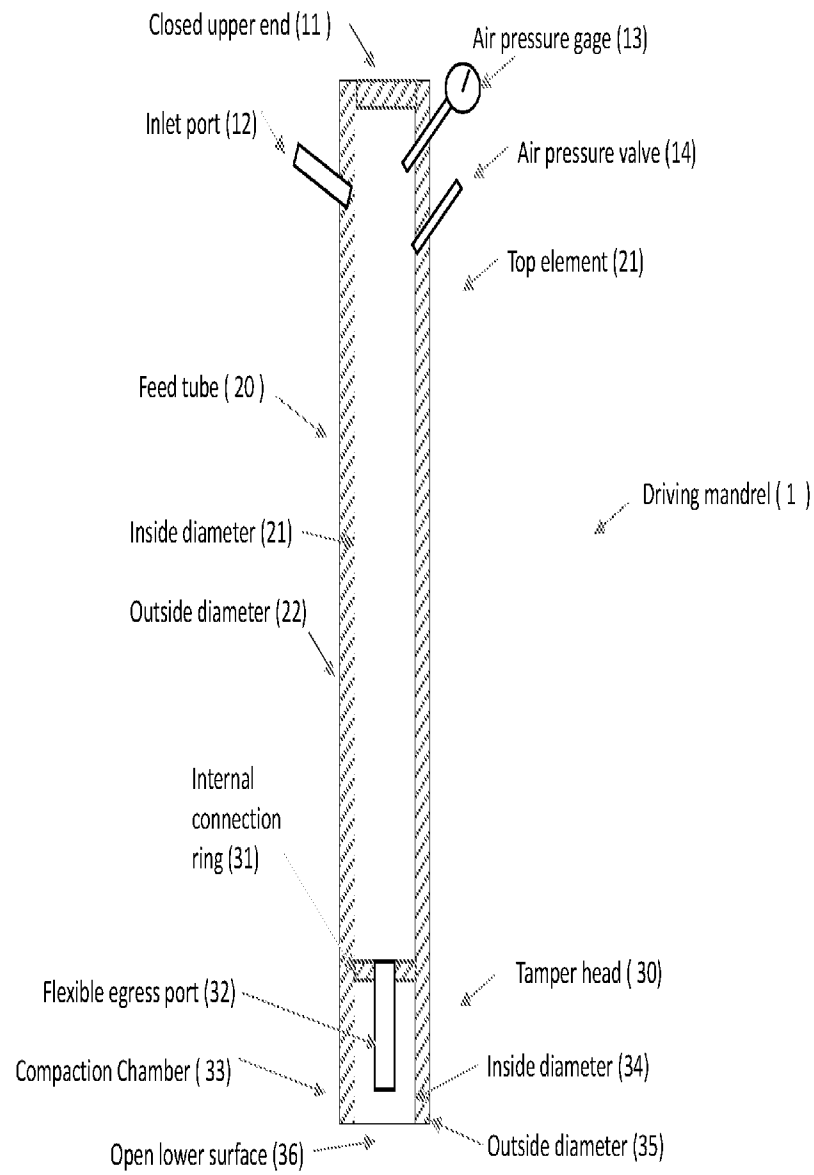


Figure 2

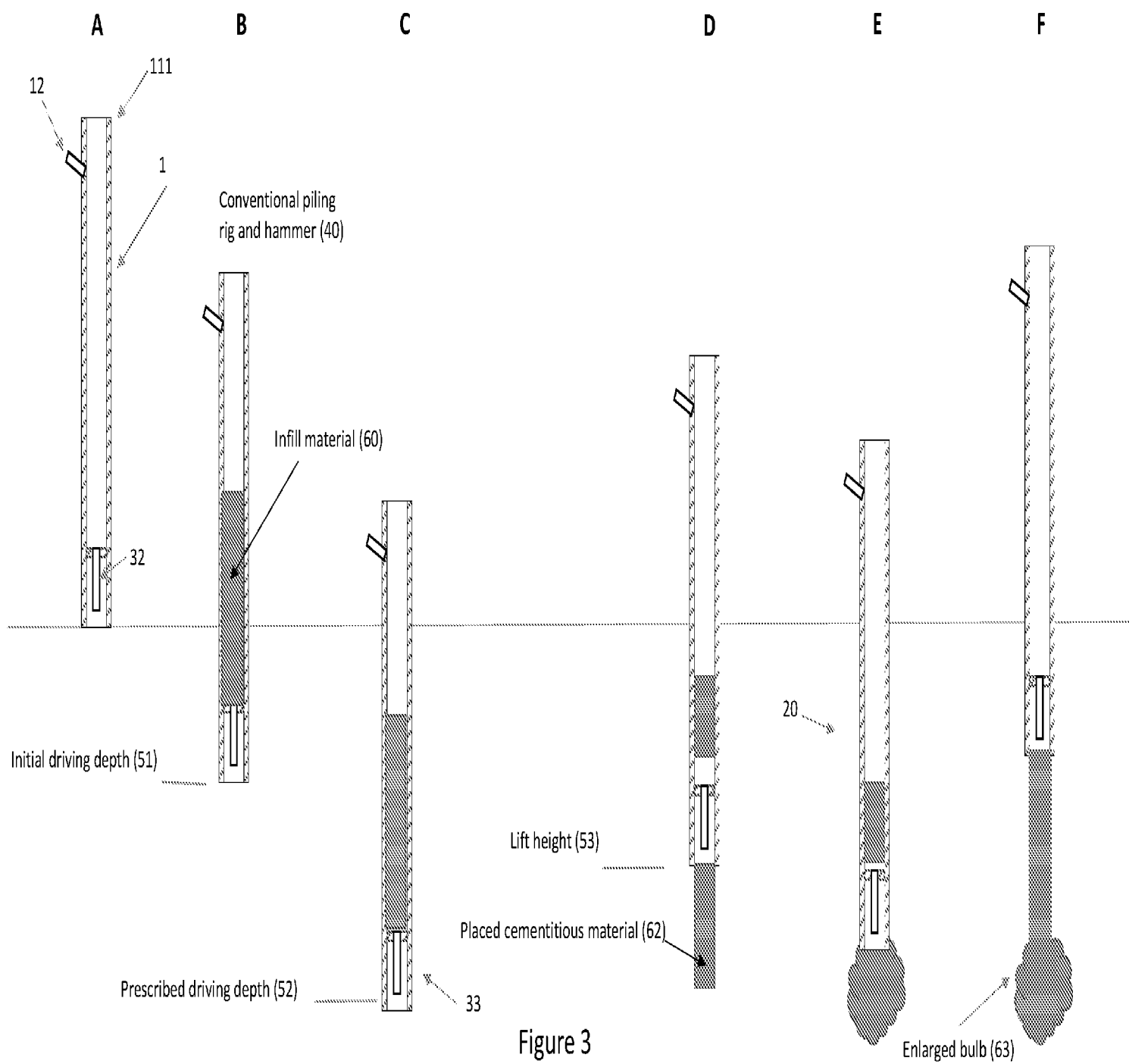


Figure 3

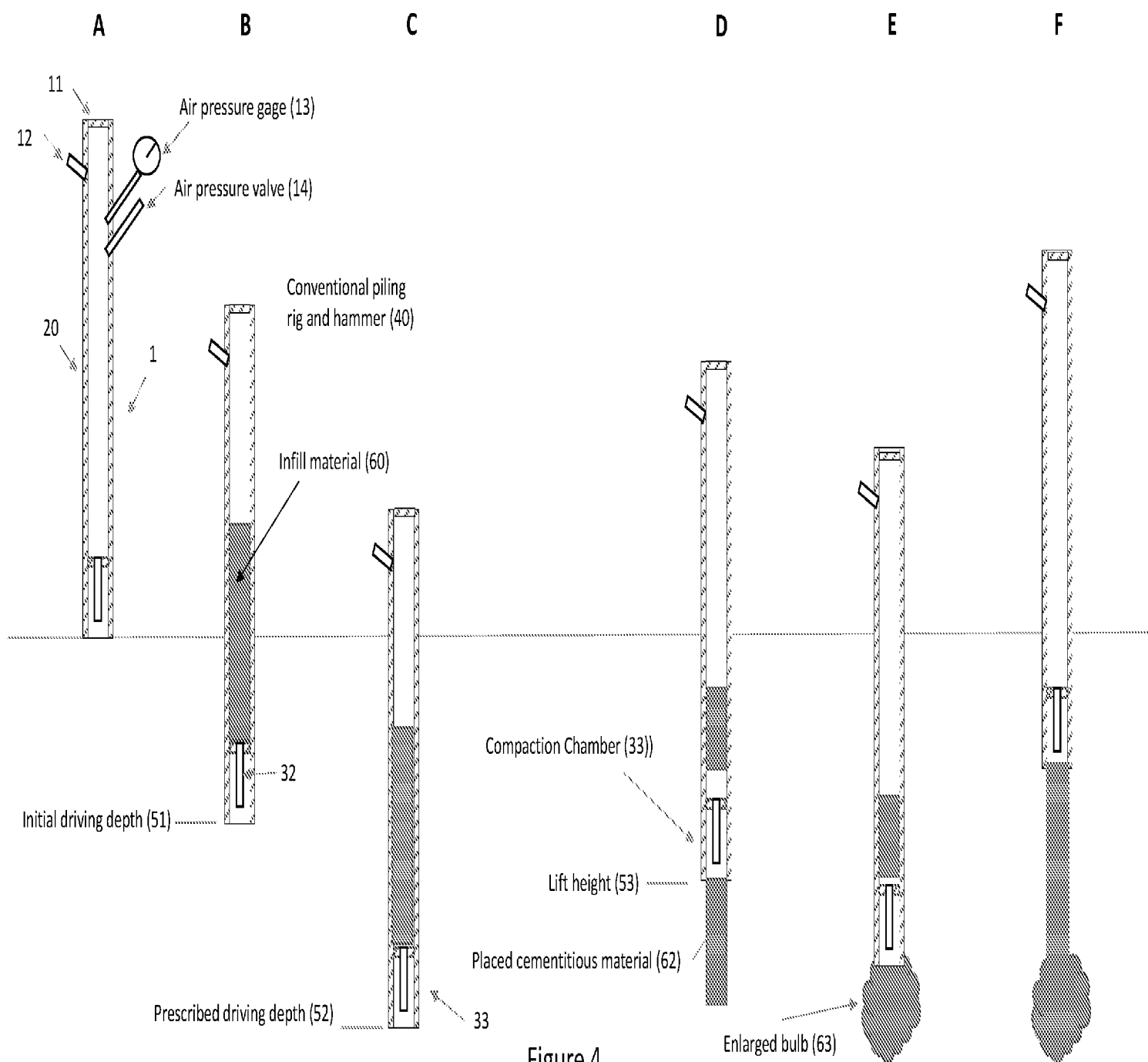


Figure 4

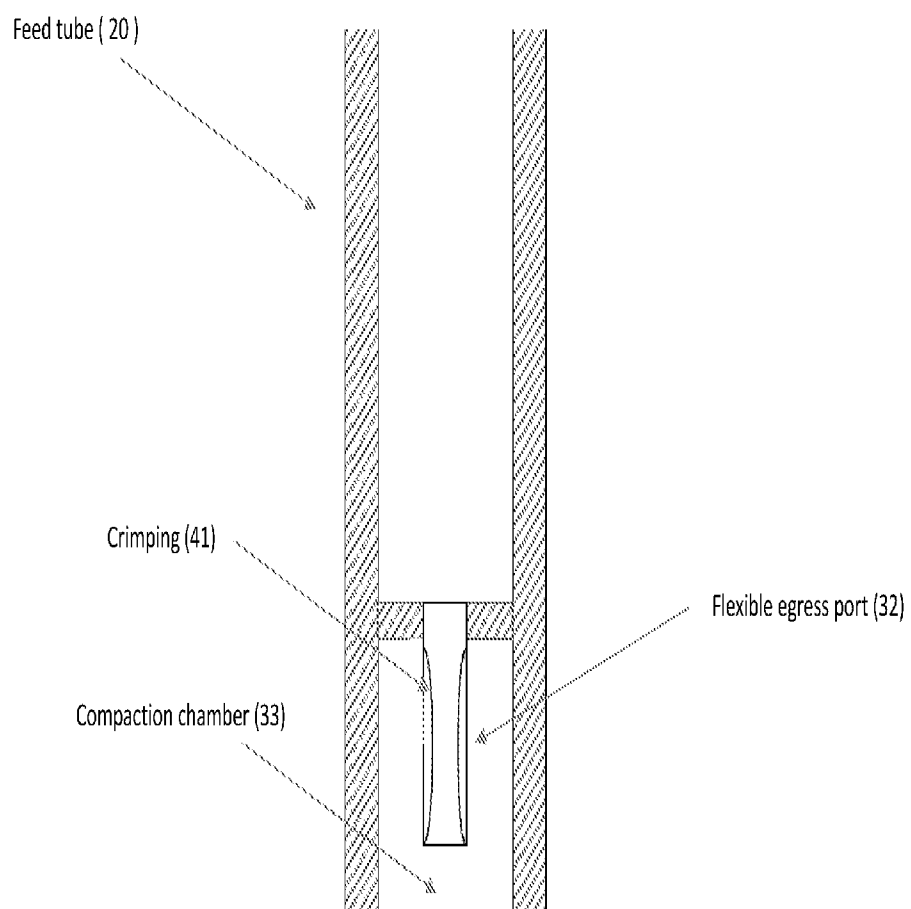


Figure 5

Electronic Acknowledgement Receipt

EFS ID:	30586794
Application Number:	62568948
International Application Number:	
Confirmation Number:	5572
Title of Invention:	Methods and Apparatus for Building Cemented Ground Support Columns
First Named Inventor/Applicant Name:	David J. White
Customer Number:	128764
Filer:	Edward Eric Mills/Elizabeth York
Filer Authorized By:	Edward Eric Mills
Attorney Docket Number:	059288-00001
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Application Type:	Provisional

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	\$ 130
RAM confirmation Number	100617INTEFSW00011311080719
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Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Provisional Cover Sheet (SB16)	CoverSheetProv.pdf	1477154	no	3
			8c01c6e84c3fd9bccc4359181df3f01dd9fd83d4		
Warnings:					
Information:					
2	Application Data Sheet	ADSProv.pdf	1822761	no	8
			d4d23d8d9774c14815f8eb6b58b16ee8e952ace3		
Warnings:					
Information:					
3	Specification	Specification.pdf	125062	no	10
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Warnings:					
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4	Drawings-only black and white line drawings	Drawings.pdf	110525	no	5
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Warnings:					
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5	Fee Worksheet (SB06)	fee-info.pdf	30557	no	2
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