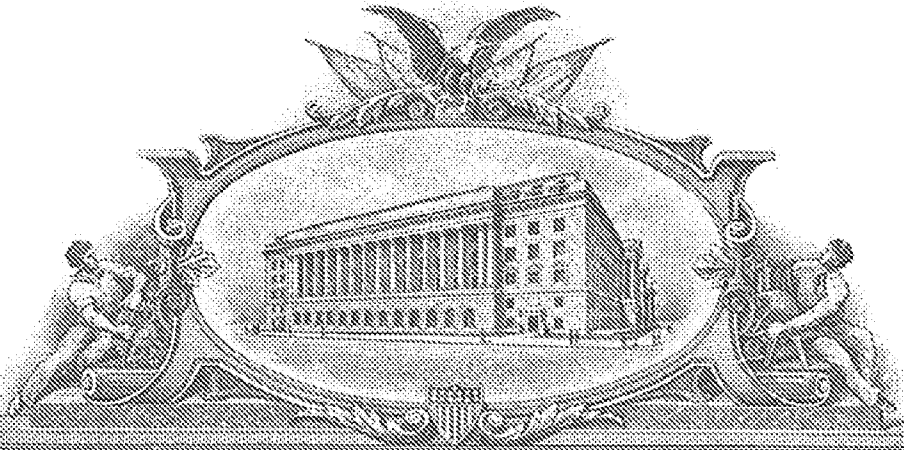


DOCUMENT MADE AVAILABLE UNDER THE PATENT COOPERATION TREATY (PCT)

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APPLICATION NUMBER: 62/752,197

FILING DATE: *October 29, 2018*

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Under Secretary of Commerce
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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	PPA19
		Application Number	
Title of Invention	Systems, methods and machines for manufacturing a foundation pile		
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.			

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☐	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.)
--------------------------	---

Inventor Information:

Inventor 1					
Legal Name					
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Residence Information (Select One) ☒ US Residency ☐ Non US Residency ☐ Active US Military Service					
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	Charles		Almy		
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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	PPA19
		Application Number	
Title of Invention	Systems, methods and machines for manufacturing a foundation pile		

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	157339		
Email Address	pmancini@ojjo.com	Add Email	Remove Email

Application Information:

Title of the Invention	Systems, methods and machines for manufacturing a foundation pile		
Attorney Docket Number	PPA19	Small Entity Status Claimed	☒
Application Type	Provisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	7	Suggested Figure for Publication (if any)	

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	157339		

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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	PPA19	
		Application Number		
Title of Invention	Systems, methods and machines for manufacturing a foundation pile			

Prefix	Given Name	Middle Name	Family Name	Suffix	Remove
Registration Number					

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Registration Number					

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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.

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) 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)

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

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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	PPA19
		Application Number	
Title of Invention	Systems, methods and machines for manufacturing a foundation pile		

☐ 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.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	PPA19
	Application Number	
Title of Invention	Systems, methods and machines for manufacturing a foundation pile	

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.

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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	PPA19
		Application Number	
Title of Invention	Systems, methods and machines for manufacturing a foundation pile		

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

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.

- ☐ 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 Ojjo, Inc.

Mailing Address Information For Applicant:

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Address 2			
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Country ¹	US	Postal Code	94947
Phone Number	415-786-4685	Fax Number	
Email Address	pmancini@ojjo.com		

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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	PPA19
		Application Number	
Title of Invention	Systems, methods and machines for manufacturing a foundation pile		

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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.				
If the Assignee or Non-Applicant Assignee is an Organization check here. ☐				
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Address 1				
Address 2				
City		State/Province		
Country i		Postal Code		
Phone Number		Fax Number		
Email Address				
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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	PPA19
		Application Number	
Title of Invention	Systems, methods and machines for manufacturing a foundation pile		

Signature:

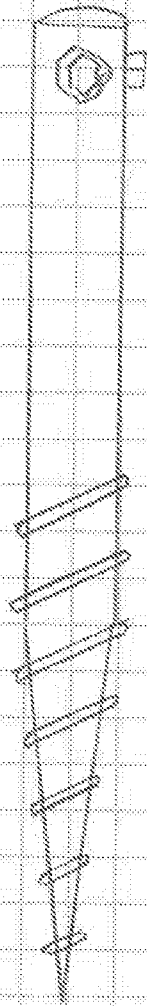
NOTE: This Application Data Sheet must be signed in accordance with 37 CFR 1.33(b). **However, if this Application Data Sheet is submitted with the INITIAL filing of the application and either box A or B is not checked in subsection 2 of the "Authorization or Opt-Out of Authorization to Permit Access" 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	/Phillip D. Mancini/			Date (YYYY-MM-DD)	
First Name	Phillip	Last Name	Mancini	Registration Number	46743
Additional Signature may be generated within this form by selecting the Add button.					

FIG. 1A



Prior Art

FIG. 1B

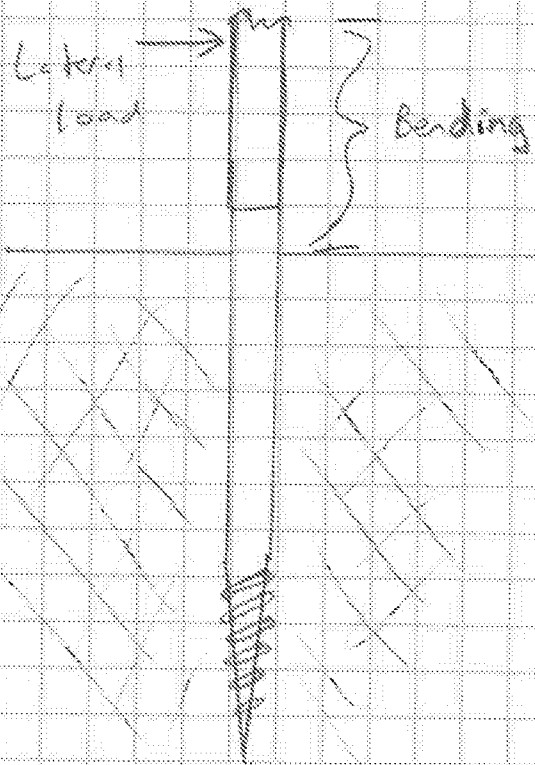


FIG. 2

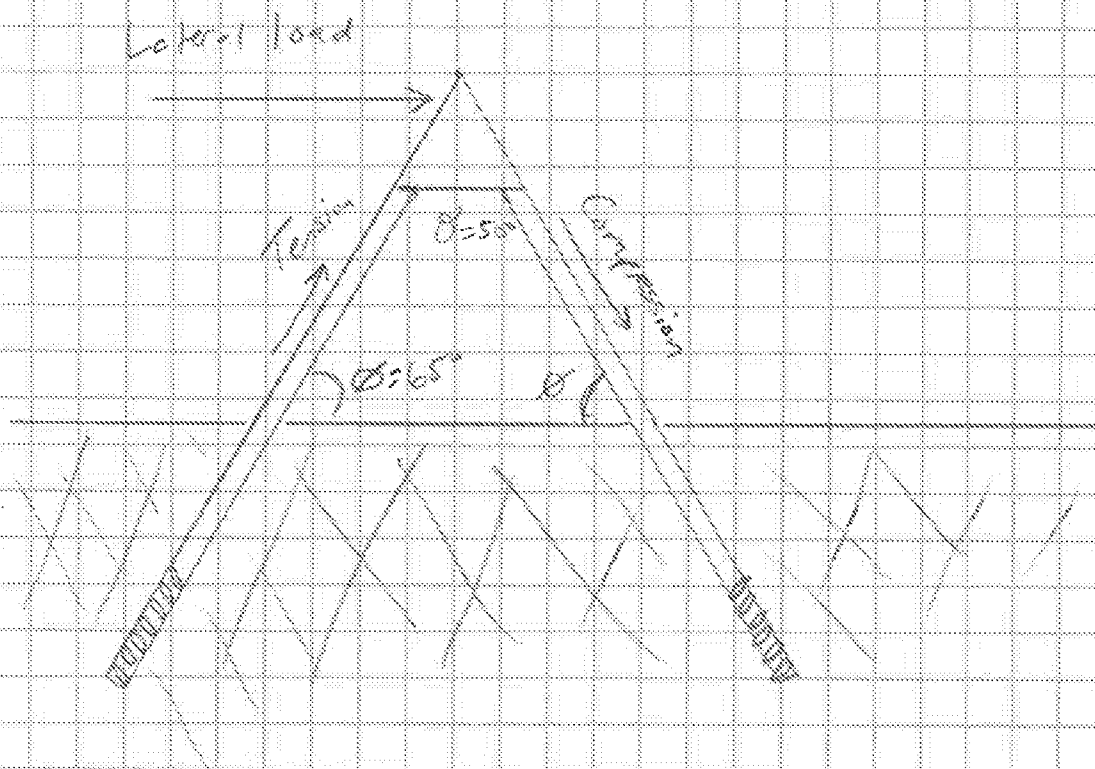


FIG. 3A



Taper,
open tip

FIG. 3B



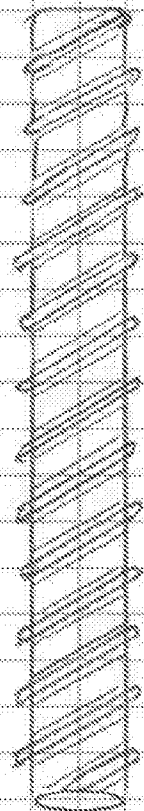
Tapered
threads,
open tip

FIG. 3C



Uniform
width,
open tip

FIG. 3D



Full thread,
open tip

FIG. 4A

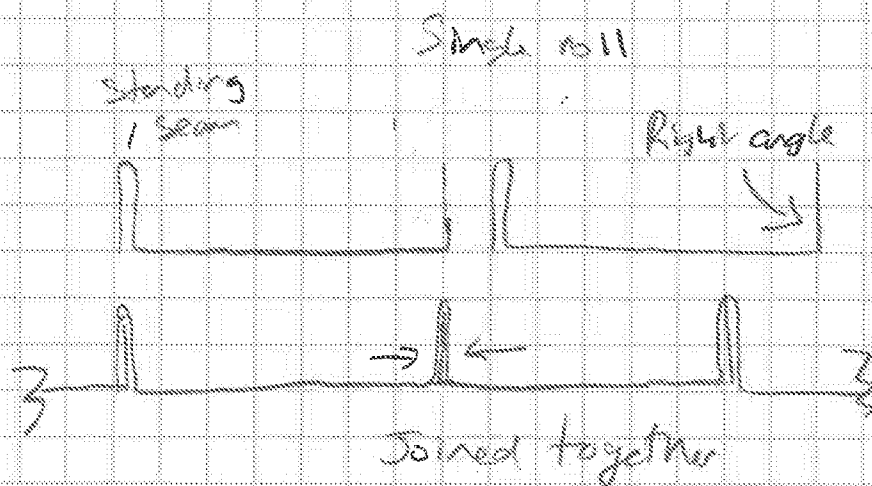


FIG. 4B

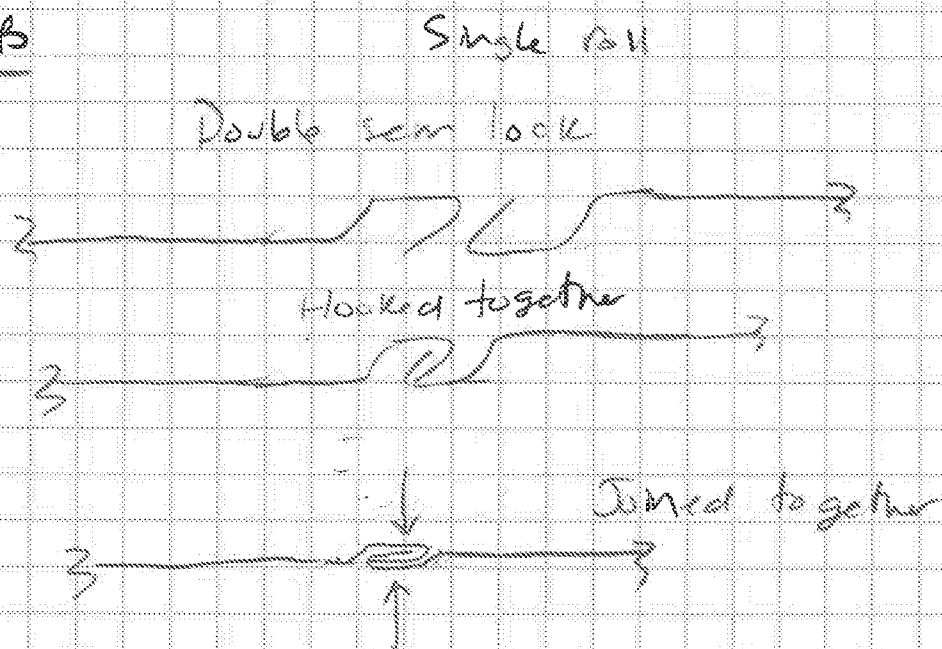


FIG. 4C

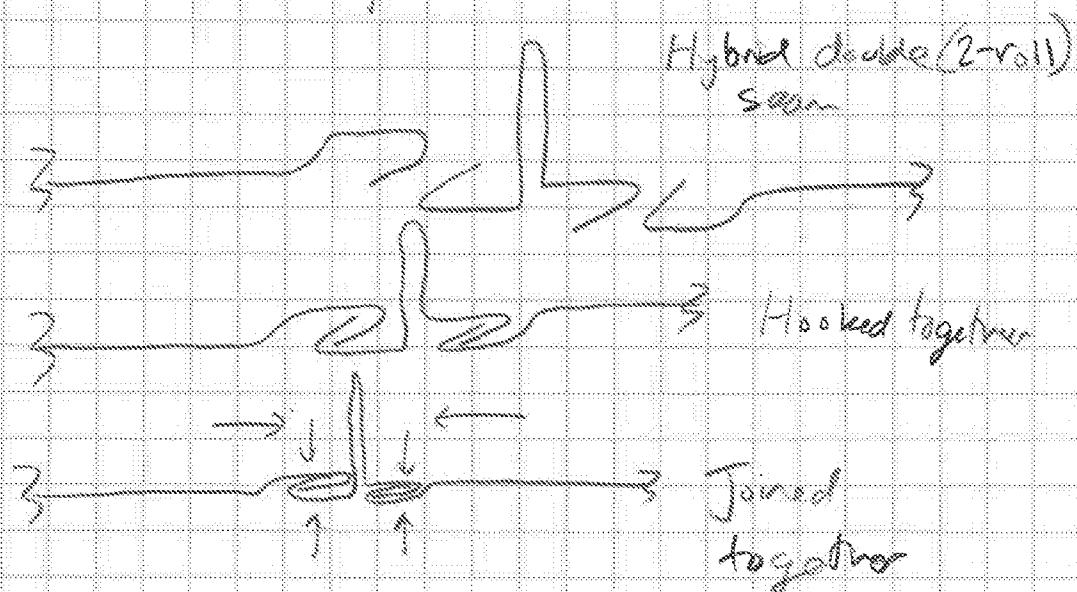


FIG. 4D

2-roll Standing seam

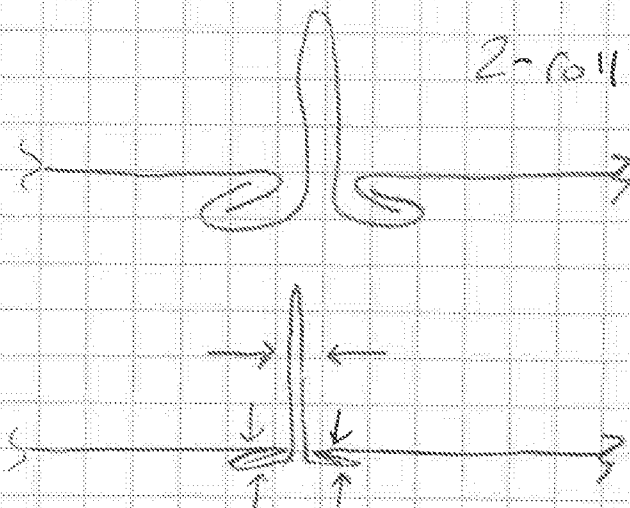


FIG. 4E

2-roll standing seam

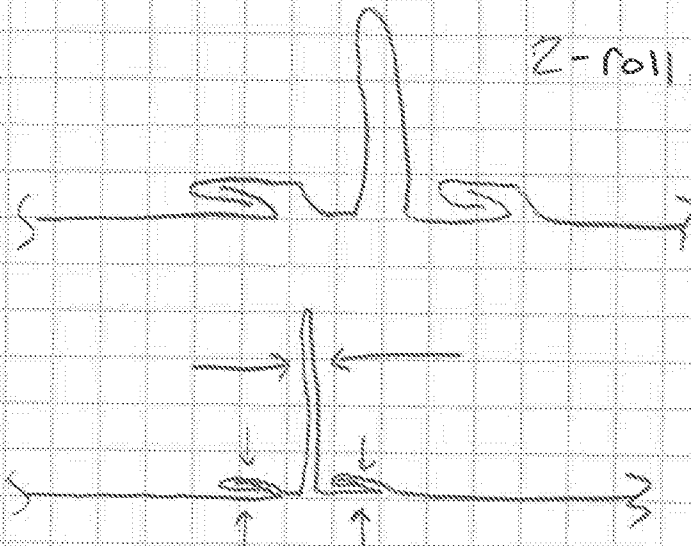


FIG. 4F

Single roll with rib

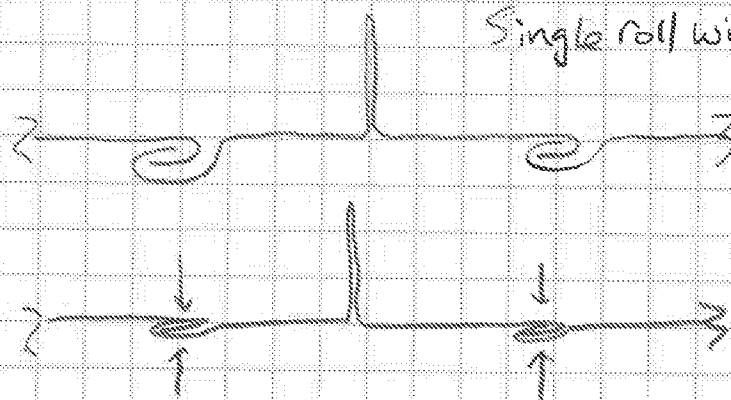


FIG. 5

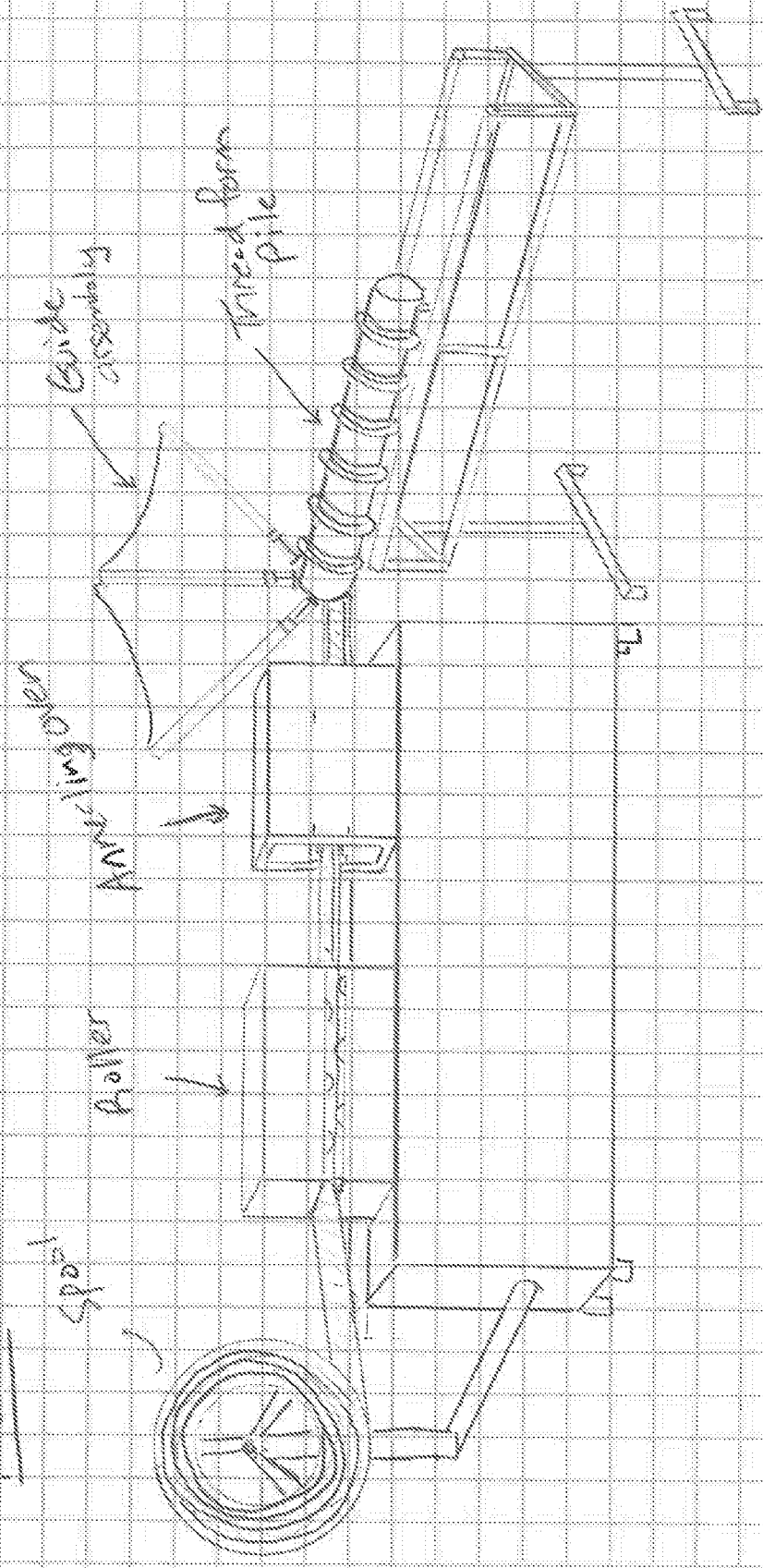
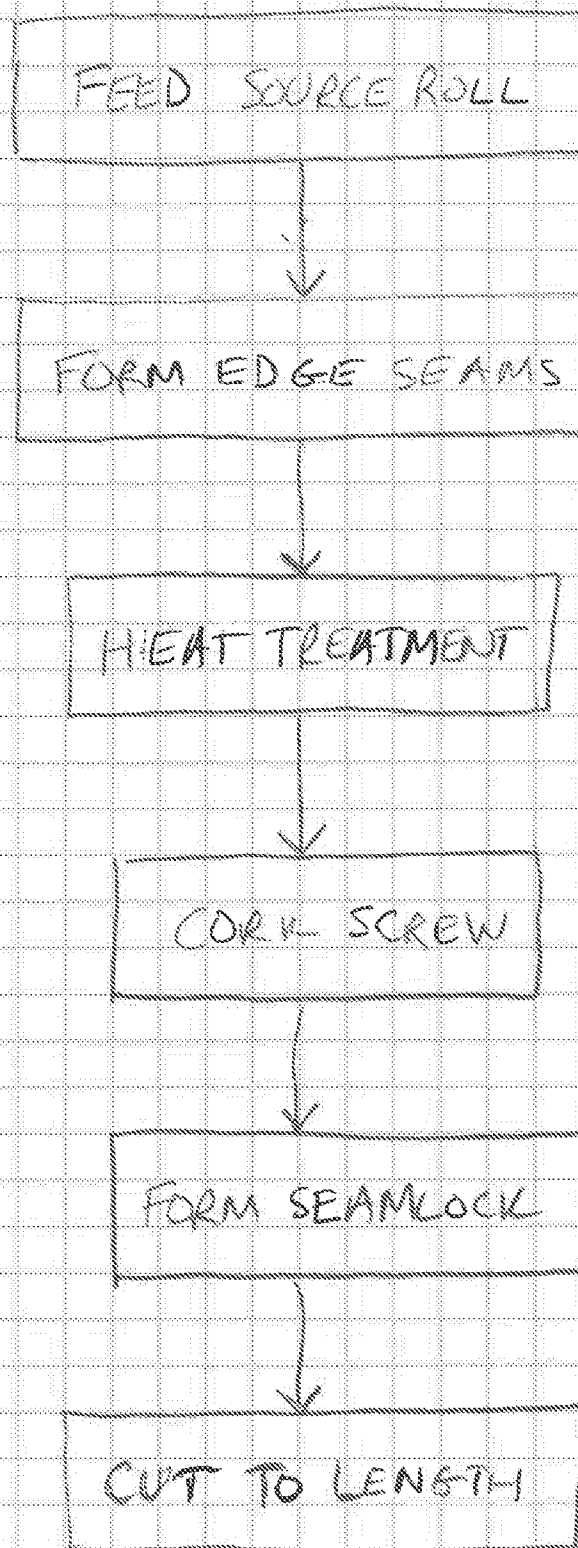


FIG. 6



Electronic Acknowledgement Receipt

EFS ID:	34151090
Application Number:	62752197
International Application Number:	
Confirmation Number:	1167
Title of Invention:	Systems, methods and machines for manufacturing a foundation pile
First Named Inventor/Applicant Name:	Tyrus Hudson
Customer Number:	157339
Filer:	Phillip Dominick Mancini
Filer Authorized By:	
Attorney Docket Number:	PPA19
Receipt Date:	29-OCT-2018
Filing Date:	
Time Stamp:	18:48:49
Application Type:	Provisional

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	\$ 140
RAM confirmation Number	103018INTEFSW18493000
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1	Application Data Sheet	WebADS.pdf	127186	no	8
			50800c2735e147b304030a9b6b74fc004865055f		
Warnings:					
Information:					
2	Specification	PPA19.pdf	127150	no	12
			34c576a1981447b06bafc13712b3455ff44a2ec1		
Warnings:					
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3	Drawings-only black and white line drawings	PPA_19DWGS.pdf	1014279	no	7
			d519bdf5a90016f06673070f7267f74fcaa11955		
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4	Fee Worksheet (SB06)	fee-info.pdf	29656	no	2
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If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

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SYSTEMS, METHODS AND MACHINES FOR MANUFACTURING A FOUNDATION PILE

BACKGROUND

[0001] Ground screws are one alternative to conventional foundation piles (e.g., H-piles, I-piles, post and cement, etc.). As the name implies, a ground screw is essentially a scaled-up, hollow version of a wood screw or self-taping metal screw, typically with an elongated, shaft and a tapered end terminating in a point. The screw also has a large, welded-on thread form extending from the point, up the taper and even partially up the shaft to enable it to be engage with soil when screwed into the ground. Such a prior art ground screw is shown, for example, in FIG. 1.

[0002] Ground screws are installed by attaching them to a rotary driver and screwing them into soil using a combination of downward pressure and rotation, much like driving a screw into wood. Usually, they are driven until they are completely or almost completely buried and then other hardware such as mounting brackets, braces, or supports may be attached to the end remaining above-ground to support signs, decks, small building frames, and single-axis solar trackers among other structures.

[0003] As with conventional screws, the ground screw's pointed tip serves at least two functions: one, it allows the screw to be precisely oriented over the insertion point and helps to keep it on path. Second, the point and taper increase pressure around the threads as the screw penetrates the soil, helping them to better grip the soil. The tip may also displace small rocks that could impede driving. A drawback of ground screws is that they are relatively difficult to manufacture as compared to H-piles, making them more expensive. The manufacturing process starts with cutting a length of rounded hollow pipe to a desired length. Then, one end of the pipe is inserted in an oven or electric heater and until it reaches a supercritical temperature. The hot end is then inserted into a shrinking machine that closes the tip to a point and imparts a taper. Once that cools, a strip of metal is formed around the pipe in a thread pattern and metal is welded to the surface of the pipe. Once cooled, the finished screw is dipped in a galvanizing solution to complete the process. The two hot-forming steps require a large amount of input energy and the welded thread form

is much more expensive than equivalent structure formed in a cold process. Also, the hot steps preclude the use of metal that has been pre-galvanized. Post manufacturing galvanization is much more expensive than starting with pre-galvanized metal.

[0004] To a large extent, the way that ground screws are currently used requires that this expensive, multi-step manufacturing process. Monopiles must be overbuilt to withstand bending forces that are orthogonal to the axis of the screw. These forces are known as lateral loads. Regardless of their geometry (e.g., screw, H-pile, I-beam, etc.), monopiles are not good at resisting lateral loads. The pile acts like a lever for the lateral load and the longer the pile the greater the magnitude of the bending force. Therefore, they must be very overly thick and heavy to stand up to these forces. Even when used in a steep A-frame configuration (e.g., with legs oriented at 75 degrees or greater), as for example, in published patent application US2008/0051915, the tensile and compressive forces on the ground screws at such steep angles are quite large and still require them to be overbuilt.

[0005] The inventors of this invention have proposed a foundation system, particularly well suited for axial solar arrays (e.g., single axis trackers and fixed-tilt ground mounted arrays), that uses a pair of adjacent angled supports configured as a moderately angled A-frame (below 72.5 degrees) instead of a single vertical pile. FIG. 2 shows an A-frame foundation pier made of two adjacent piles driven into the ground at opposing 65-degree angles with respect to the ground. With any A-frame, lateral loads impart axial forces of tension and compression on the piles instead of putting them in bending, however, the magnitude of those forces increases exponentially at steeper angles. Because straight piles (ground screws, H-piles, etc.) are good at resisting axial forces, the members making up the legs of the A-frame can be smaller relative to monopiles. As a result, the A-frame geometry allows different manufacturing techniques to be employed that may not work for monopiles or piles used in steep A-frames. Therefore, there is a need for screw piles and manufacturing methods and machines for making such screw piles that take advantage of the drivability and resistance to pullout and compression of grounds screws but that are optimized for the different force profiles present in a moderately sloped A-frame.

DESCRIPTION

[0006] The invention will now be described in the context of the drawing figures where like elements are referred to with like designations. Turning to FIGS. 3A-3D, these figures show four exemplary screw piles according to various embodiments of the invention. Unlike conventional ground screws, the screw piles of FIGS. 3A-3D are open at both ends. As discussed in greater detail herein, having the ends open not only eliminates hot process steps, it allows a mandrel, rock drill or other device to be inserted through the body of the pile during installation and without needing to first remove the pile. In various embodiments, these piles will be driven into the ground adjacent one another and joined together with a pile cap or other structure above ground to complete the A-frame. As discussed herein, when used to support a single-axis solar tracker or other axially oriented structure, lateral loads will impart tensile and compressive forces to the legs of the A-frame.

[0007] In various embodiments, and as discussed in greater detail herein, the exemplary screw piles shown in FIGS. 3A-3D are manufactured using a variant of a spiral duct forming machine or so-called spiral tube former. Such a machine is shown for example, at FIG. 5. The machine takes a roll of sheet metal having a nominal width (e.g., three to five inches or 75-125 mm) and thickness (e.g., 25 gauge down to 16 gauge or even lower) to form pipes using sheet metal seam locking techniques. The rolled sheet metal is feed with an automatic feeding mechanism into a roller assembly that performs the necessary edge treatment to enable the seam lock to be formed. Once the edge treatment is complete, the leading edge is fed into a corkscrew or simply curled back on itself with one or more guides so that the metal bends back on itself, putting the pre-formed left edge exiting the corkscrew adjacent the right edge entering the corkscrew adjacent one another. The adjacent edges enter a seam locker where they are joined together. As the sheet stock continues moving through the machine, a tube begins to project outward from the seam locker until the feeding stops. A saw or plasma cutter located just past the seam locker then cuts the tube to length.

[0008] The diameter of the pipe formed by such a machine will be dictated by a couple of factors. First, there is a limit to how tightly a given thickness of metal can be bent. That

being the case, smaller thinner stock will be capable of being formed into narrower width tubes than thicker stock, all other factors being equal. Second, for a given width stock, the more tightly it is curved back on itself to form the standing lock seam, the greater the thread pitch will be (i.e., distance between adjacent threads). Although tube forming machines can handle a variety of gauges of sheet metal and can produce tubes of varying diameter, they are often unable to form the smallest diameter pipes using the thickest sheet stock. For solar foundation piles, the desired diameter may be three inches or even less, yet this application requires that relatively thick sheet steel be used (e.g., 1-1.5 millimeters). To make a pipe having such a small diameter with heavy gauge sheet metal, it may be desirable to anneal the metal somewhere between the edge rolling and the seaming locking stage. In various embodiments this may be accomplished by passing the sheet stock through a process annealer, a set of hot rollers or other suitable sub-critical heat source to make the metal more pliable without recrystallizing it. As the metal cools the tube will already be formed, adding extra strength to its shape. This type of sub-critical heating is characterized as a warm process step, as opposed to a hot one.

[0009] It should be appreciated, and as will be discussed in greater detail herein, when forming tubes for HVAC ductwork, the seams are usually deemphasized or pressed as flat as possible (e.g., double seam lock) since the primary purpose is to make them airtight. Also, geometries that restrict airflow are generally avoided. By contrast, when using an analogous tube forming process to form threaded foundation piles, it may be desirable to emphasize or even to exaggerate the seam. In various embodiments, this may include utilizing one of a variety of different standing seam profiles as opposed to a double seam lock, that forms a relatively large seam (e.g., $\frac{1}{4}$ inch up to 1 inch) that projects outward radially from the face of the tube. It may also be desirable to increase the pitch (e.g., distance between adjacent seams along the tube's axis) since the seam will function as a thread.

[0010] Turning to the figures, the pile of FIG. 3A is a two-piece pile with threads and a taper. In various embodiments, both sections making up the pile are formed via a metal seam locking technique applied to a roll of sheet metal in the range of 24 gauge down to 16

gauge or even lower. The unthreaded uniform section may be formed with a low prolife seam lock (e.g., double seam lock) while the tapered threaded section may be formed using one of several possible standing seam lock techniques. In other embodiments, the unthreaded uniform section may simply be a section of pipe cut to the appropriate length. In various embodiments, the first and second pieces may be swaged together to form the two-piece pile. Alternatively, or in conjunction, they may include reciprocal features that allow them to be screw locked together. For example, the smooth section may have threads formed at one end that allow it to be screwed over or inside of the threads formed on the threaded pile section. In still further embodiments, one or more rivets, welds, set screws or other fasteners or fastening techniques may be used to join the smooth and threaded pile sections together.

[0011] The machine used to form such a pile is a variant of a spiral duct machine such as that shown in FIG. 5. A spiral duct machine takes a roll of steel sheet metal, unwinds it into a roller assembly that preforms the edge seams into the desired shape and then compresses the seams together to form a tube. The tube extends away from the machine, orthogonally from the feed direction of the sheet metal as it is being formed. However, a spiral duct machine does not typically include an annealing oven or even a heat source because it is not necessary when forming larger diameter pipes and tubes.

[0012] The pile of FIG. 3B is also a two-piece pile, however, the threaded portion of the pile is not tapered. Rather, the threads themselves get smaller as they reach the pile tip. This may be accomplished, for example, by incorporating a piece of sheet metal into a standing seam lock that increases in width to form the threaded portion of the pile. This may also be accomplished by dynamically controlling the roller assembly as the tube is being formed to make the thread diameter increase. Like the pile of 3A, the smooth portion may also be made using a seam lock technique or may be formed from a section of rounded pipe and may be joined in the same manner.

[0013] The pile shown in FIG. 3C is another two-piece pile having a threaded section and a non-threaded section, however, in this example, neither the threads nor the pile itself are tapered. Instead, the diameter remains uniform over the entire length except for the

additional diameter created by the threads. The benefits of a tapered point discussed herein may be provided by a mandrel or other like device projecting out of the threaded end during driving without having to form the taper on the pile itself. The threaded portion of this pile may also be formed from a standing seam lock while the uniform portion may be made from a double seam lock or section of standard pile. Again, the two sections may be joined together using any of the methods discussed herein.

[0014] Finally, FIG. 3D shows a one-piece pile made entirely from a single length of rolled sheet metal with its edges joined with a standing seam. Here the standing seam runs the entire length of the pile. This may be simpler and less expensive to manufacture than a two-piece pile even if the threads at or near the top of the pile contribute very little to the pile's resistance to axial forces.

[0015] In various embodiments, a pile such as that shown in FIGS. 3A-3D will be rotated into the ground using a rotary driver or other like device. The rotary driver may rotate the pile from the top or may be partially or fully inserted into the pile to rotate it from within. Because the various screw piles disclosed herein are open at both ends, and as discussed in other co-pending applications, it may be desirable to insert a mandrel or a ground/rock drill into the shaft of the pile from above during driving to clear a path ahead of the pile, to increase soil pressure around the thread form, and even to excavate a cavity in solid rock to receive the pile. In various embodiments, the top of each of the piles shown in FIGS. 3A-D may have one or more holes formed in it so that the head of a rotary driver can be pinned to it for driving. In other embodiments, the top of the pile may have a plate or other structure attached to it that can mate with the rotary driver. Also, as with the prior art ground screw of FIG. 1, the pile may have one or more openings to receive set screws that allow the pile to be mated with above-ground components. The above-ground details of the pile are intentionally omitted here.

[0016] Turning now to FIGS. 4A – 4F, these figures show exemplary seam geometries that may be usable to form screw piles according to various embodiments of the invention. Starting with 4A, this figure shows a conventional standing seam. The standing seam is formed by joining adjacent edges together consisting of a folded loop (the standing seam)

and a right angle (a single upward projecting edge). The standing seam portion fits over the right angle like a hood and the two are pinched together to make a tight seam by compressing either side of the standing seam. 4B shows what is known as a double seam lock. Opposing edges receive reciprocal treatment to form a pair of opposing hooks that can be interlocked and then compressed to form a flat, seam with four layers of material.

[0017] FIGS. 4C-4E are hybrid standing seams that rely on two rolls of feed stock. All these designs have a double seam lock geometry on both sides while the second roll is shaped into a standing seam with a pair of hooks on either side. The hooks of the standing seam are joined with the hooks of the primary feedstock to form a seam that has a double seam lock on either side of standing seam. One advantage of these configurations is that it may be possible to use a different gauge or type of material for the standing seam than for the body of the tube.

[0018] FIG. 4F shows a hybrid double seam standing seam lock. Edges are joined with a double seam lock, but a standing seam rib is made in approximately the middle of the stock. This allows for a robust double seam to be used, as opposed to the single seam of the standing seam of FIG. 4A. Also, by moving the rib away from the seam, pressure on the rib is not translated directly into the seam.

[0019] FIG. 6 is a flow chart showing the steps of a method for forming a foundation pile according to various embodiments of the invention. The method begins by loading a roll of feed material on to the machines spool holder. In various embodiments and as discussed herein, the roll may be 16-25-gauge sheet metal with a width in a range of 2.5 to 6 inches. The free end of the roll is then fed into a roller assembly so that the edge seams can be formed. In various embodiments, the machine will feed itself after the material is initially fed in. That is, the roller assembly will continue to pull the material through. The shape formed into the edges will depend on the desired seam type. As the material exits the roller assembly, or in some embodiments, while it passes through the roller assembly, it will be heated. This may consist of using one or more hot rollers in the roller assembly or passing the material through an annealing oven or other sub-critical heat source to increase its pliability. The material is then corkscrewed back on itself. In some embodiments, this

may be done with a rounded guide or other devices that simply guides the leading edge through a loop so that what was the left edge of the material as it was being formed in the roller assembly is now adjacent to the right edge of trailing material before that trailing material hits the corkscrew. At this point, the two edges are joined with a seam locker that orients and compresses them together to interlock the seams. This last step forms the pipe in real time. The length of the pipe continues growing until the roller assembly is paused. An integral saw or plasma cutter located just past the seam locker is activated to cut the pipe into a fixed length. The process may then be restarted to product another pipe section.

[0020] The embodiments of the present invention are not to be limited in scope by the specific embodiments described herein. For example, although many of the embodiments disclosed herein have been described with reference to systems and methods for installing foundation for axial solar arrays, the principles herein are equally applicable to foundations for other structures. Indeed, various modifications of the embodiments of the present invention, in addition to those described herein, will be apparent to those of ordinary skill in the art from the foregoing description and accompanying drawings. Thus, such modifications are intended to fall within the scope of the following appended claims. Accordingly, the claims set forth below should be construed in view of the full breath and spirit of the embodiments of the present inventions as disclosed herein.

CLAIMS**Claim Set One**

1. A foundation pile for an axial solar array comprising:
an elongated pile member having an opening at both ends; and
a substantially orthogonal thread form projecting radially out of the surface of the elongated pile, wherein the pile and thread form are created substantially at the same time through an automated sheet metal tube forming process where one edge of the sheet metal is curved into a loop and attached to the opposing edge with a standing seam lock.
2. The foundation pile according to claim 1, wherein the standing seam lock projects out radially from the pile and has a height in a range of $\frac{1}{4}$ of an inch to 1 inch.
3. The foundation pile according to claim 2, wherein the standing seam lock is oriented at a non-orthogonal angle with respect to the pile's surface.
4. The foundation pile according to claim 1, further comprising a second elongated pile member having a smooth surface and joined to one end of the first pile member to form a foundation pile having a thread form at one end.
5. The foundation pile according to claim 4, wherein the second elongated pile member and first elongated pile member are swaged together.
6. The foundation pile according to claim 4, wherein the second elongated pile member has a thread form on one end, the thread form dimensioned to mate with the thread form formed from the standing seam on the first elongated pile member.
7. The foundation pile according to claim 1, wherein the sheet metal is exposed to heat prior to being curved into a loop.
8. The foundation pile according to claim 7, wherein the heat has a temperature in a range of 260 to 760 degrees Celsius.

Claim Set Two

9. A method of forming a foundation pile for an axial solar array comprising:
feeding one end of a roll of sheet metal into a roller assembly;
deforming first and second edges of the fed sheet metal with the roller assembly into opposing sides of a seam lock;

process annealing the formed sheet metal at a subcritical temperature;
 feeding the one end of the annealed metal into a corkscrew guide to curve it back on itself so that the first edge is adjacent to the second edge;
 locking the first edge to the second edge with a seam locker to form a foundation pile with a thread form, the thread form having a height in a range of $\frac{1}{4}$ of an inch to 1 inch; and
 cutting the foundation pile to a desired length, the cut being orthogonal to the pile's length.

10. The method according to claim 9, wherein process annealing comprises heating the sheet metal to a temperature between 260 to 760 degrees Celsius.

11. The method according to claim 9, wherein the standing seam lock is oriented at a non-orthogonal angle with respect to an outer surface of the pile.

Claim Set Three

12. A method of forming a foundation pile for an axial solar array comprising:
 feeding one end of a first roll of sheet metal into a first roller assembly;
 feeding one end of a second roll of sheet metal into a second roller assembly;
 deforming first and second edges of the first roll of sheet metal with the roller assembly into opposing sides of a seam lock;
 deforming first and second edges of the second roll of sheet metal with the roller assembly into opposing sides of a seam lock;
 process annealing the formed sheet metal from the first and second rolls in an annealing oven at a subcritical temperature;
 feeding the annealed metal from the first roll into a corkscrew guide to curve it back on itself so that the first edge is proximate to the second edge;
 feeding the proximate edges along with the metal from the second roll into a seam locker; and
 locking the first edge and second edge of the annealed metal from the first roll to respective first and second edges of the annealed metal from the second roll to form a tube with a standing seam thread form, the standing seam thread form having a height in a range of $\frac{1}{4}$ of an inch to 1 inch; and

cutting the tube to a desired length, the cut being orthogonal to the tube's length.

13. The method according to claim 12, wherein process annealing comprises heating the sheet metal from the first and second rolls to a temperature between 260 to 760 degrees Celsius.

14. The method according to claim 12, wherein the standing seam lock is oriented at a non-orthogonal angle with respect to a surface of the tube.

Claim Set Four

15. A machine for making a screw pile comprising:

a spool holder for rotatably holding a spool of sheet metal; and

a conveyor system, the conveyor system comprising:

a roller assembly, the roller assembly pulling a free end of the sheet metal through its length and having a series of rollers configured to impart a seam lock form to respective first and second edges of the sheet metal as it passes through the first roller assembly;

an annealing oven configured to perform process annealing on the formed sheet metal as it passes through;

a corkscrew guide for directing the sheet metal back on itself so that the first edge is adjacent the second edge; and

a seam locker for locking the first edge to the second edge with a standing seam lock to form a spiral tube having a thread form, the thread form projecting radially outward from a center of the tube at a height in a range between $\frac{1}{4}$ inch and 1 inch.

16. The machine according to claim 15, wherein the seam locker forms the standing seam at a non-orthogonal angle with respect to a surface of the tube.

Claim Set Five

17. A method of forming a screw pile for an axial solar array comprising:

feeding one end of a roll of sheet metal into a roller assembly;

forming a rib in a middle portion of the sheet metal with the roller assembly, the rib running with the roll;

forming first and second edges of the sheet metal with the roller assembly into opposing sides of a seam lock;

process annealing the formed sheet metal in an annealing oven at a subcritical temperature;

feeding the one end of the annealed sheet metal into a corkscrew guide to curve it back on itself so that the first edge is adjacent to the second edge;

locking the first edge to the second edge with a standing seam lock to form a tube with the rib pointing away from the center of the tube, the thread form having a height in a range of $\frac{1}{4}$ of an inch to 1 inch; and

cutting the tube to a desired length to form the screw pile, the cut being orthogonal to the tube's length.

18. The method according to claim 17, wherein process annealing comprises heating the sheet metal to a temperature between 260 to 760 degrees Celsius.

19. The method according to claim 17, wherein the rib is oriented at a non-orthogonal angle with respect to a surface of the pile.