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(56) Documents Cited:
WO 2001/090488 A1 **CA 002100298 A**
DE 003905462 A1 **JP 060299531 A**
JP 2009287225 A **US 20020148298 A1**

(58) Field of Search:
INT CL **E02D**
Other: **Epodoc & WPI**

(54) Title of the Invention: **Ground anchor**
Abstract Title: **Setting a ground anchor by using a strain gauge type device**

(57) The invention relates to a method of setting ground anchors by using a strain gauge type device. The ground anchor may be a helical or screw pile, an auger, a soil nail, a bore hole device or a ground drill. The strain gauge device may be a strain gauge, a piezo or magnetic type device. There may also be a torque transducer or moment sensor. Data may be communicated wirelessly to a remote PC. Also disclosed is a flange or connection plate 4 for use in setting ground anchors.

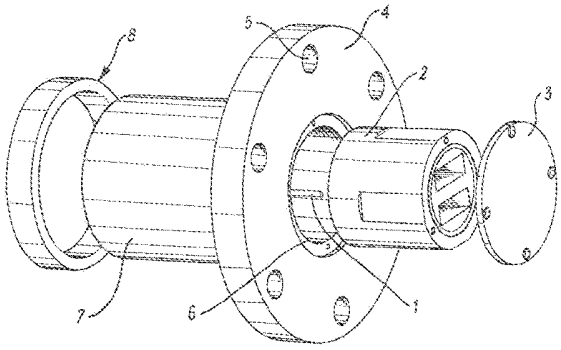

Fig 1

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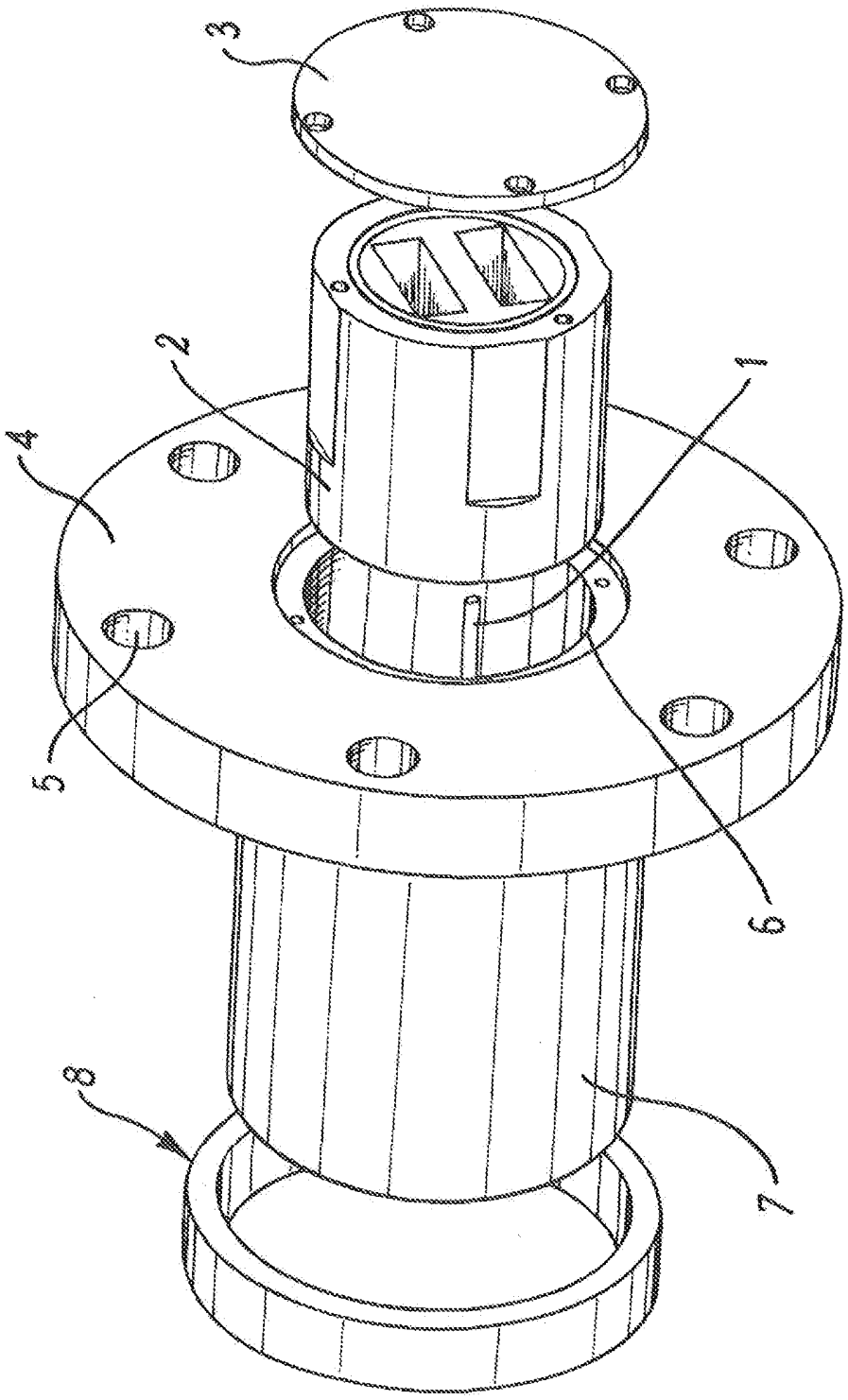

Fig.1

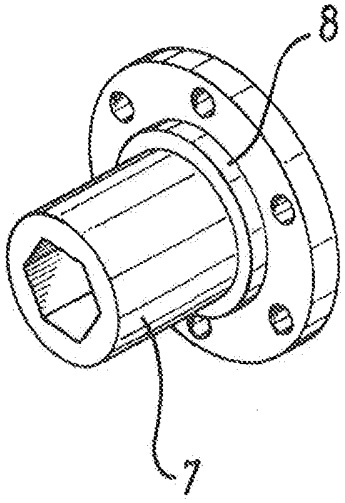

Fig.2

Ground Anchor

The invention relates to the setting of ground anchors and is particularly, although not exclusively, concerned with the setting of helical (screw) piles.

The setting of helical (screw) piles by the measurement of applied torque is a practice generally adopted within the helical (screw) pile industry. This method is, however, unreliable due to variations in how the torque is measured and the ground conditions into which the pile is installed.

In detail, the practice of interpreting applied torque at the pile tip by measuring the hydraulic pressure at the 'torque-head' can lead to false recording of up to 35% on pile installation torque. This is dependant upon the quality (e.g. efficiency) of the torque-head equipment used; hydraulic back pressure generated by the hydraulic power unit (excavator); the degree of maintenance of the torque-head and the calculation of friction losses within the system; the theoretical torque delivered to the tip of the pile may be inaccurate to as much as + or - 35% as compared to that specified in the 'design'.

This could inevitably lead to a reduced pile depth since generally pile driving torque increases as the depth of the pile increases. This condition can inevitably lead to reduced factors of safety (FoS) in design against ultimate loads; uncertainty in foundation settlement and inadequate ground mass to prevent uplift on the pile. It could also lead to over engineering due to increased installation depth. A further pitfall in using applied torque to set the pile depth is the uncertainty of the ground conditions through which the pile is being installed. Current practice adopted by some companies states that once the applied torque setting is reached the pile

installation is stopped, depending on depth. This approach takes no account of any inconsistencies in ground conditions, for example

- What if the torque setting is reached when the pile tip reaches a stiff stratum or obstruction?
- Has the pile been set to the correct depth?
- Will the pile design load capacity be achievable?

These questions cannot be answered without further design and site investigation.

It is therefore an object of the present invention to improve the method of setting ground anchors, such as helical (screw) piles, so as to overcome the above-described disadvantages without requiring further site investigation or compromising safety.

According to a first aspect of the present invention, there is provided a method of setting a ground anchor by using a strain gauge type device.

According to a second aspect of the present invention, there is provided the use of a strain gauge type device to set a ground anchor.

According to a third aspect of the present invention, there is provided a kit comprising a ground anchor and a strain gauge type device.

According to a fourth aspect of the present invention, there is provided a strain gauge type device for use in setting ground anchors.

According to a fifth aspect of the present invention, there is provided a flange or connection plate for use in setting a ground anchor.

The present invention facilitates setting of ground anchors, such as helical (screw) piles, in a safer and more accurate manner, and without the need for further site investigation.

Preferably the ground anchor is a helical (screw) pile, an auger, a soil nail, a bore hole device or ground drill.

Preferably the strain gauge type device enables setting of the ground anchor by measuring output torque, preferably the output torque of a power unit, including a torque head, power head or any other rotary drilling device. Preferably the strain gauge type device is a strain gauge or a similar device such as a piezo or magnetic type device.

Preferably the strain gauge type device is part of a flange to flange reaction torque transducer, preferably incorporating fully potted electronics which facilitate wireless communication of data to a remote handheld indicator or similar (eg an internet based indicator). Strain gauge type devices have previously been used in marine applications, but have not previously been used in the field of setting ground anchors.

By way of background it is mentioned that a Torque Transducer (also commonly known as a Torque Sensor) measures torque by a variety of methods. Torque is defined as the moment of a force, a measure of its tendency to produce torsion and rotation about an axis

A Torque Sensor is a transducer that converts a torsional mechanical input into an electrical output signal. It measures the 'force' being used in turning an element. When a 'force' or 'torque' is applied to a shaft; the shaft twists which in turn creates an 'elongation' in the shaft's material. This elongation creates a

separation between points of the shaft by a twisting motion in the direction of 45° from the shaft's axis. The material of the shaft is also 'compressed' in the opposite 45 ° direction. Torque transducers measure this reaction in order to calculate the torque. It is commonly known that strain gauges are the most reliable methods of measuring this shaft twist. Strain gauges are bonded to the shaft, measuring the strain induced in the shaft by the applied torque or 'force'.

The flange to flange reaction Torque Transducers of the present invention, when combined with the fully plotted electronics, transmit digital data to a handheld or internet based indicator thereby providing the Engineer with accurate output data.

An on-shaft signal is provided by a Wheatstone Bridge or similar methodology which is amplified and converted into a digital value. This signal is transmitted off the shaft and then processed digitally and amplified; this signal is taken off the shaft and then processed to provide a measurement of torque.

Preferably the measured torque data is transmitted from the torque transducer via a wireless data transfer mechanism which is powered by re-chargeable standard 'C' size batteries which are either NiMH re-chargeable or non re-chargeable alkaline cells.

The PDA or other (eg internet based) interface preferably has an antenna for receiving data from the torque transducer and preferably also a USB interface for transferring data to a PC.

The PDA or internet based system and software provides a simple to use visual indication of the installation torque with logging facilities.

Preferably the strain gauge type device is used in combination with a flange or connection plate, and preferably this flange/connection plate houses the strain gauge type device. Preferably the flange/connection plate is also attached to a power unit, and preferably the flange/connection plate is situated between a power head (to provide the torque) and the ground anchor. Ideally the flange/connection plate is attached to the rotational flange of the power head or similar. The shape of the flange/connection plate is dependant on the elements to which it is attached, but preferably it is generally tubular with a lip at one end. Preferably the tube is of circular cross section on its external face (when viewed along its longitudinal axis), and preferably the lip is also of circular cross section (along the same axis). Preferably the lip comprises at least one peripheral hole, and preferably it comprises about 6 peripheral holes. Preferably the tube is of triangular, quadrilateral, pentagonal, or hexagonal (preferably hexagonal) cross section on its internal face (when viewed along its longitudinal axis), for at least a portion of its length, preferably at the end opposite to the lip. Preferably the tube is of circular cross section on its internal face (when used along the longitudinal axis) at the end bearing the lip. Preferably the flange/connection plate is robust and/or watertight.

The invention will now be illustrated by the accompanying drawings in which:

Figure 1 is an exploded diagram of a torque transducer and a flange/connection plate;

Figure 2 is an alternative view of the connection plate in Figure 1.

Referring to Figure 1, this shows a flange/connection plate 1 which houses a torque transducer 2. A cover 3 protects the torque transducer. The flange/connection plate comprises a lip 4 which comprises six peripheral holes 5. The end 6 of the

flange/connection plate bearing the lip 4 has a circular cross section on its internal face (when viewed along the longitudinal axis of the flange/connection plate), wherein this circular cross section is sized to receive the transducer 2. The opposite end 7 of the flange/connection plate bears a coil ring 8.

Referring now to Figure 2, this shows that the end 7 of the flange/connection plate has a hexagonal internal cavity (i.e. a hexagonal internal cross section when viewed along the longitudinal axis of the flange/connection plate). Figure 2 also shows the coil ring 8 in its fitted position.

Claims

1. A method of setting a ground anchor by using a strain gauge type device.

2. Use of a strain gauge type device to set a ground anchor.

3. A kit comprising a ground anchor and a strain gauge type device.

4. A strain gauge type device for use in setting ground anchors.

5. A flange or connection plate for use in setting a ground anchor.

6. The method, use, kit, strain gauge type device or flange or connection plate of any preceding claim, wherein the ground anchor is a helical (screw) pile, an auger, a soil nail, a bore hole device or ground drill.

7. The method, use, kit or strain gauge type device of any of claims 1-4, wherein the strain gauge type device enables setting of the ground anchor by measuring output torque, preferably the output torque of a power unit such as a torque head, power head or any other rotary drilling device.

8. The method, use, kit or strain gauge type device of any of claims 1-4, wherein the strain gauge type device is a strain gauge or a piezo or magnetic type device.

Application No: GB0913204.4 **Examiner:** Mr Virgil Scott

Claims searched: 1-4, 6 (in part), 7, 8 **Date of search:** 21 October 2010

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1-4, 6-8	WO01/90488 A1 (MURE) See figure 2 with strain gauge device 14
X	1-4, 6-8	JP06299531 A (TAKADA) See abstract translation for magnet based torque sensor
X	1-4, 6-8	DE3905462 A1 (SCHWARZ) See figure 2 for strain gauge 4
X	1-4, 6-8	CA2100298 A (BURTELSON) See whole document
X	1-4, 6-8	JP2009287225 A (SASAKI) See abstract translation
X	1-4, 8	US2002/148298 A1 (MCVAY) See strain gauge 211 in figure 2

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{X} :

Worldwide search of patent documents classified in the following areas of the IPC

E02D

The following online and other databases have been used in the preparation of this search report

Epodoc & WPI

International Classification:

Subclass	Subgroup	Valid From
E02D	0007/22	01/01/2006
E02D	0005/56	01/01/2006
E02D	0005/80	01/01/2006