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(54) PROFILER FOR INSTALLATION OF FOUNDATION SCREW ANCHORS

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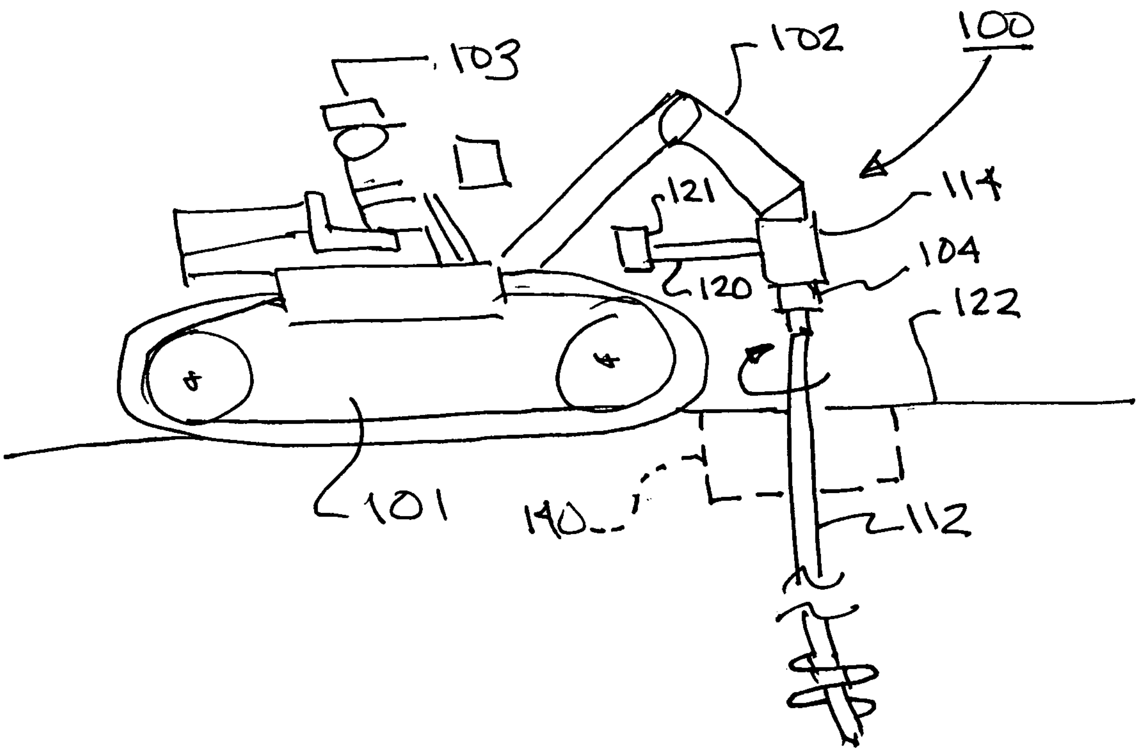
(57) **ABSTRACT**

A profiler for use in the installation of a screw anchor for connecting to foundations and the like. The profiler provides a readout of torque being applied by a hydraulic motor which rotates the drill head and screw anchor. The profiler further provides a range sensor which indicates the distance traveled by the drill head and, hence, the distance traveled by the screw anchor into the ground formation. An orientation sensor for the screw anchor may conveniently also be used in the operation of the profiler.



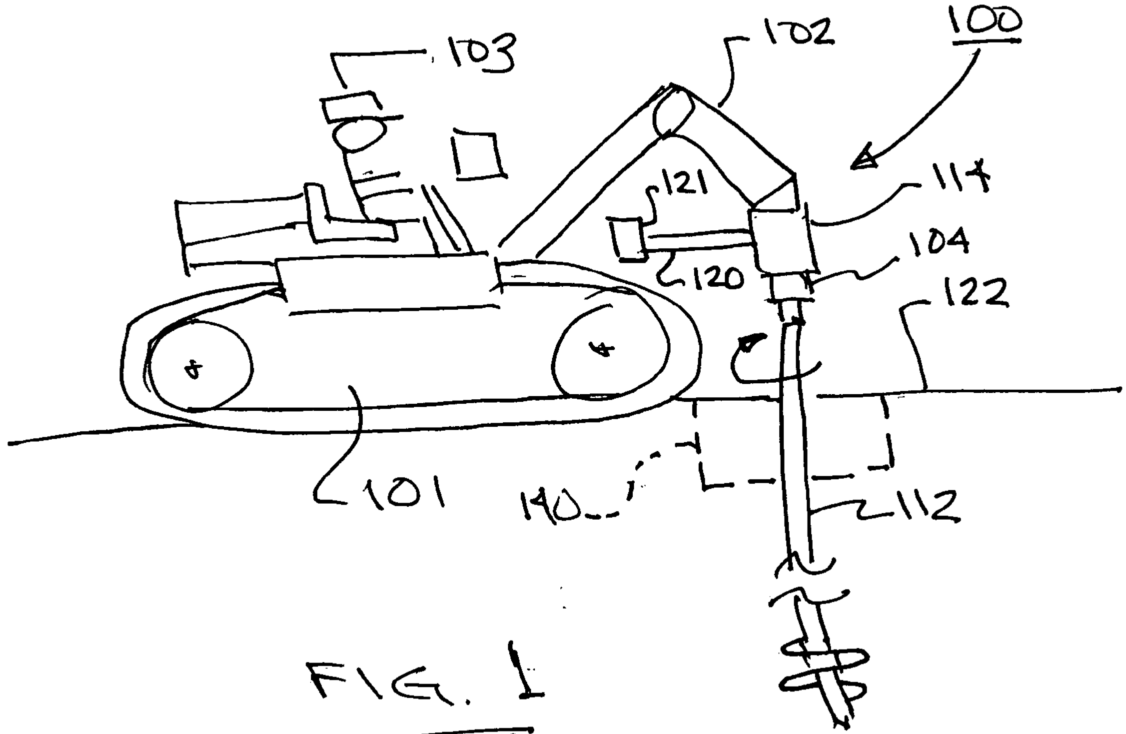

100
102
103
121
114
104
120
122
101
140
112

FIG. 1

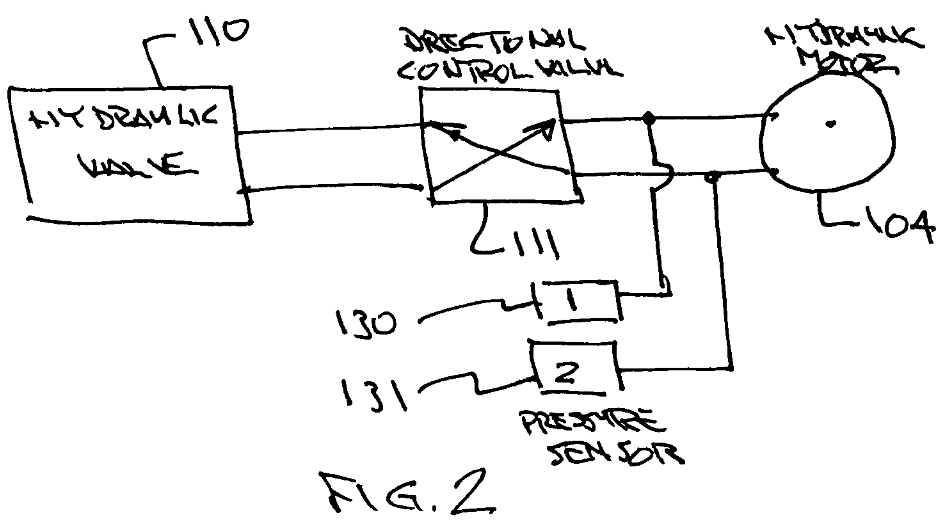

110
HYDRAULIC VALVE
DIRECTIONAL CONTROL VALVE
111
HYDRAULIC MOTOR
104
130
1
131
2
PRESSURE SENSOR

FIG. 2

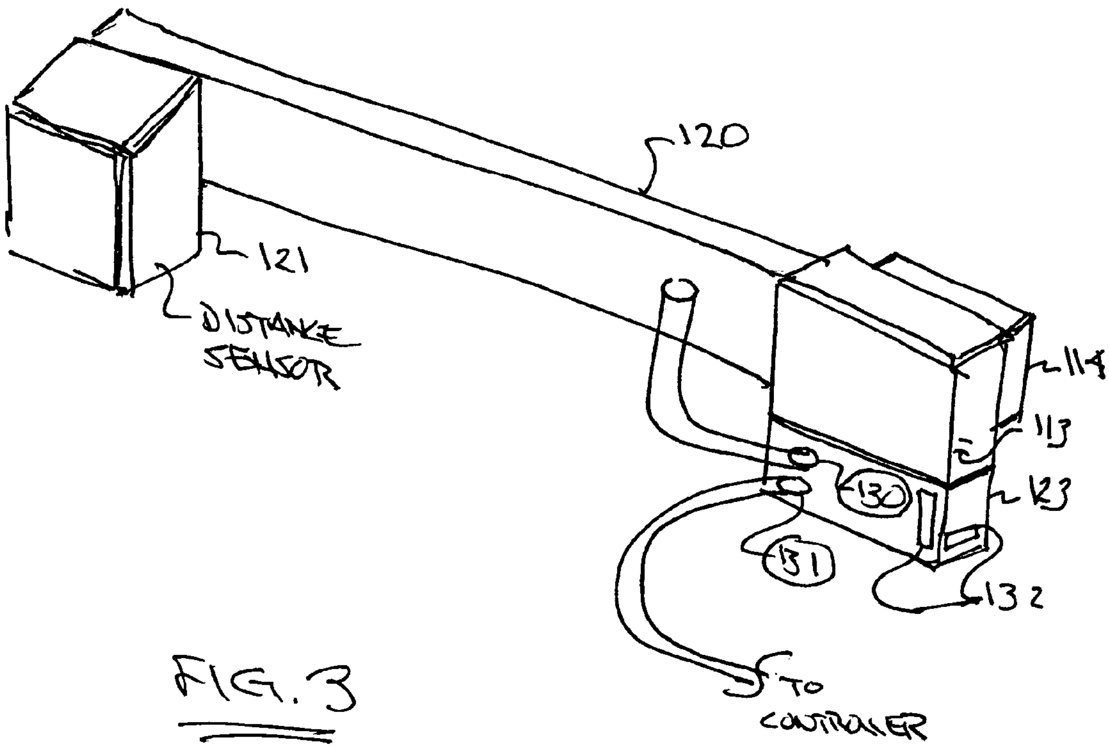

120
121
DISTANCE SENSOR
114
113
123
130
131
132
TO CONTROLLER

FIG. 3

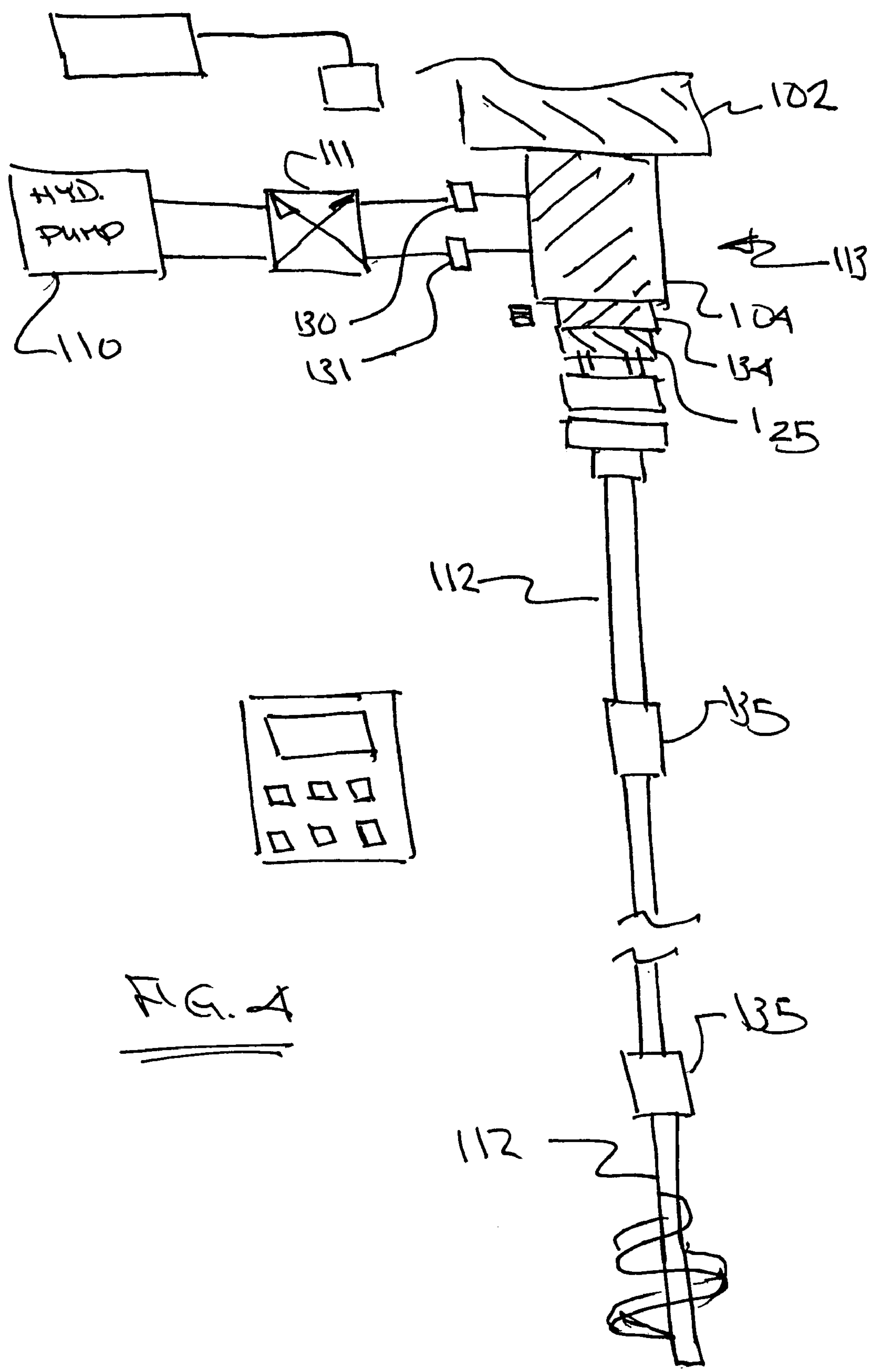


FIG. 4

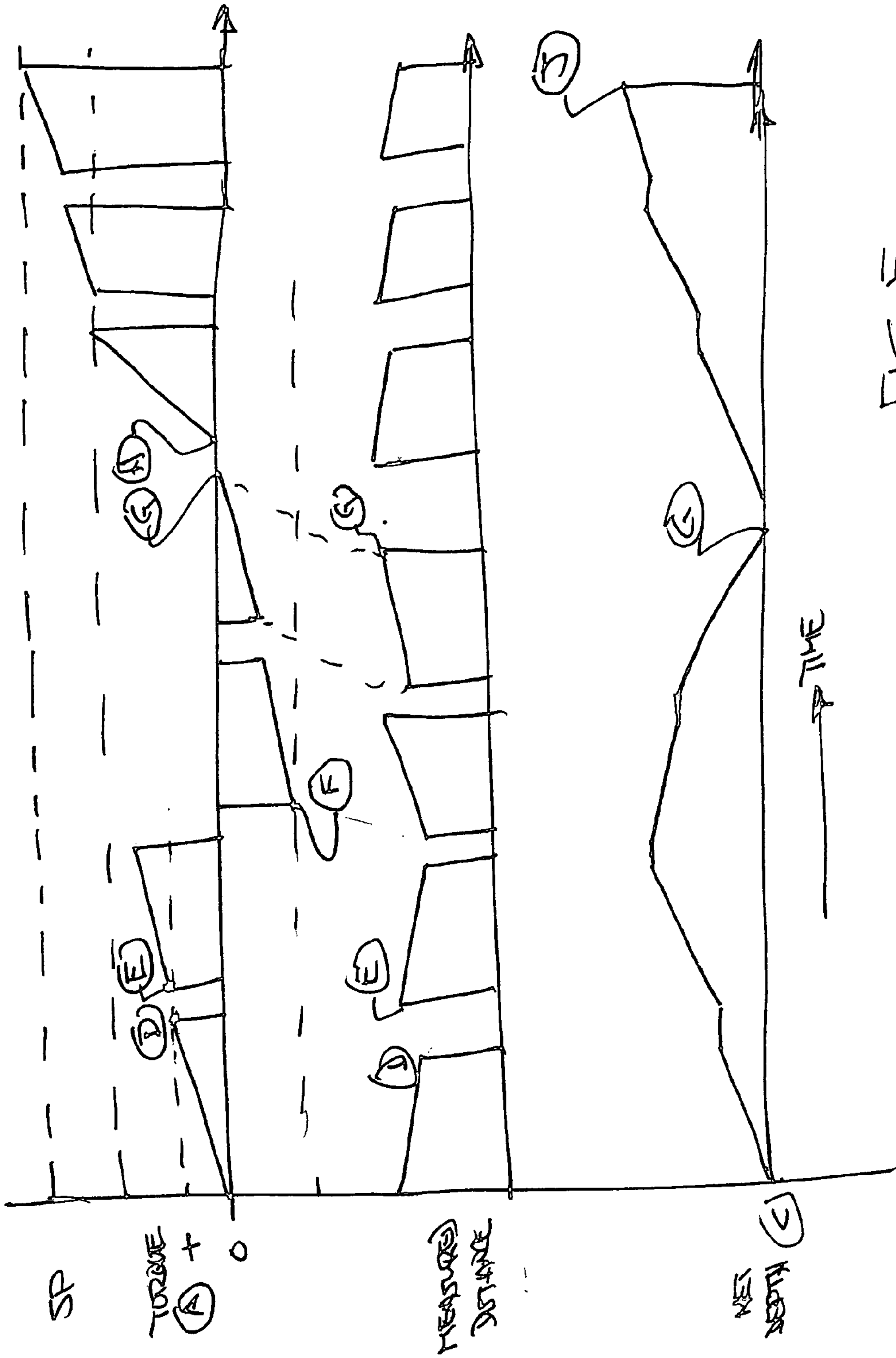


FIG. 5

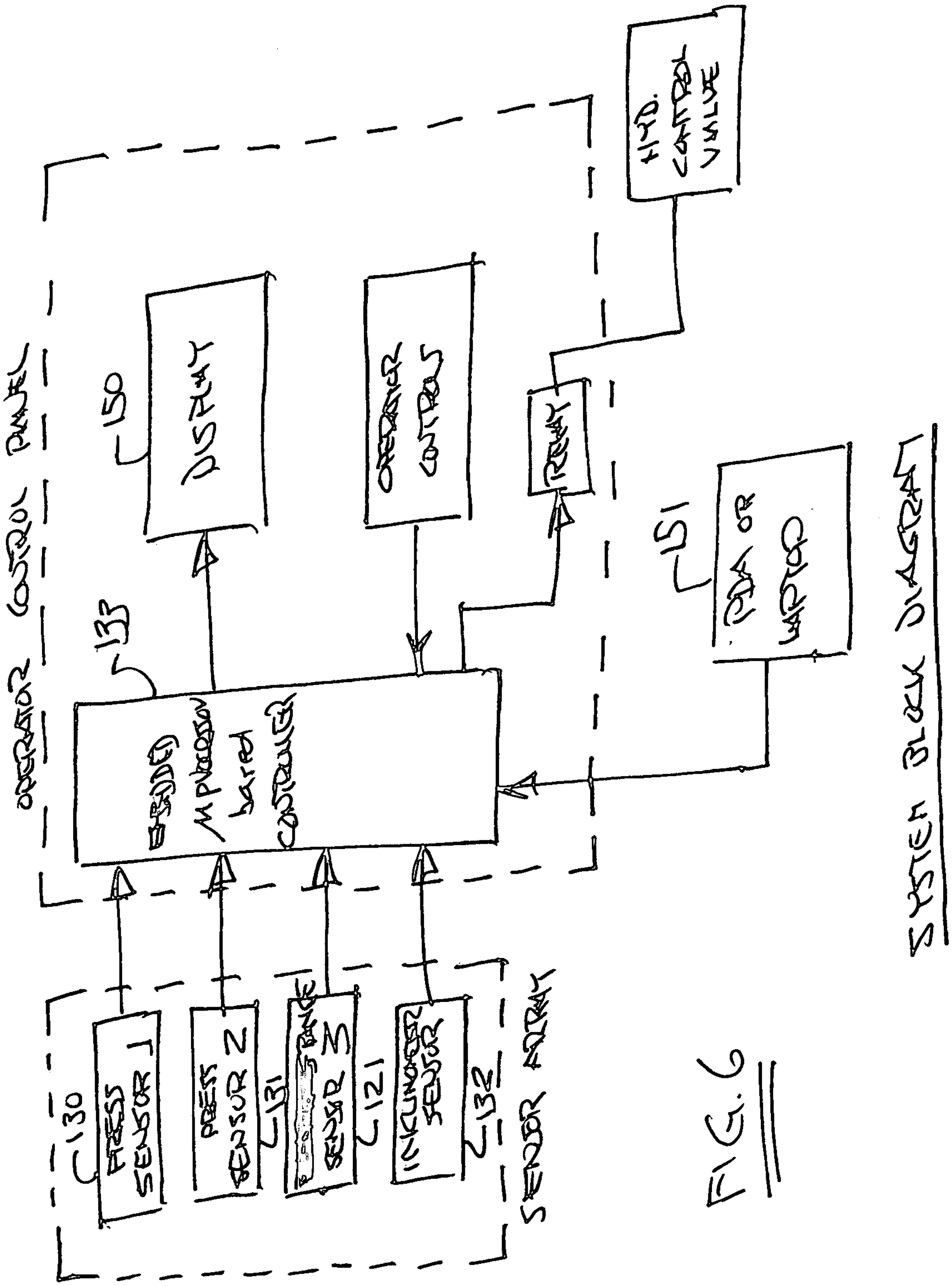

OPERATOR CONTROL PANEL
150
DISPLAY
OPERATOR CONTROLS
RELAY
HYD. CONTROL VALVE
133
EMBEDDED MPROCESSOR BASED CONTROLLER
151
PDA OR LAPTOP
130
PRESS SENSOR 1
131
PRESS SENSOR 2
121
STROKE SENSOR 3
132
INCLINOMETER SENSOR
SENSOR ARRAY
SYSTEM BLOCK DIAGRAM

FIG. 6

PROFILER FOR INSTALLATION OF FOUNDATION SCREW ANCHORS

INTRODUCTION

[0001] This invention relates to a profiler and, more particularly to a profiler used to provide real-time information concerning the installation of foundation screw anchors.

BACKGROUND OF THE INVENTION

[0002] Screw type foundation piles, piers and anchors are conventionally used in construction projects to remedy failing foundations in existing structures as well as to provide foundation support for new construction. There are advantages to screw type foundation piles over more traditional type foundation support methods such as caissons and pile driven supports.

[0003] In the installation of screw type foundation piles, it is advantageous to obtain a real time display of torque being applied to the screw type foundation and, in addition, to obtain such torque indication and the depth profile of the screw anchor being installed.

SUMMARY OF THE INVENTION

[0004] According to one aspect of the invention, there is provided a profiler for installation of foundation supports such as screw anchors and screw piers, said profiler comprising a first sensor to measure inlet pressure to a hydraulic motor used to rotate said screw anchor, a second sensor to measure outlet pressure from said hydraulic motor, said first and second sensors being utilized to determine torque being applied to said screw anchor by said hydraulic motor, a third sensor to measure the distance traveled by said screw anchor in an earth formation and means for comparing said distance traveled by said screw anchor with said torque applied to said screw anchor over said distance.

[0005] According to a further aspect of the invention, there is provided a method of installing a screw anchor comprising applying a torque to said screw anchor by a motor connected to a drill head, allowing said screw anchor to move into a ground formation under the influence of said torque, determining the value of said torque applied to said screw anchor while said screw anchor moves into said ground formation and comparing the torque applied to said screw anchor with the distance traveled by said screw anchor in said ground formation.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0006] Specific embodiments of the invention will now be described, by way of example only, with the use of drawings, in which:

[0007] **FIG. 1** is a diagrammatic side view of the helical drill or screw anchor being installed into a ground formation by an operator in a typical application while using the profiler according to the invention;

[0008] **FIG. 2** is a diagrammatic schematic of the control system which provides torque indication of the torque applied to the screw anchor by the hydraulic motor;

[0009] **FIG. 3** is a diagrammatic and enlarged view of the profiler hardware which is attached to the drill head applying torque to the screw anchor;

[0010] **FIG. 4** is a side diagrammatic and enlarged view of the drilling equipment with attached screw anchors;

[0011] **FIG. 5** is a graphical representation of the torque, measured distance and net depth reached by the screw anchor; and

[0012] **FIG. 6** is a block diagram of the profiler system including the controller and sensors of the profiler.

DESCRIPTION OF SPECIFIC EMBODIMENT

[0013] Referring now to the drawings, a profiler used for the installation of a foundation support is generally illustrated at **100** in **FIG. 1**. It is installed on a tractor **101** which has a boom **102** connected thereto which boom **102** is extended outwardly or inwardly by an operator **103** as the particular job may require. A hydraulic motor **104** (**FIG. 4**) is connected to the extended end of the boom **102** and may be rotated by the operator **103** through a hydraulic pump **110** which uses a directional control valve **111** to control the direction of rotation of the drill head **134** by controlling the direction of hydraulic fluid flow through the motor **104** by directional control valve **111** which thereby retracts or installs the screw anchor **112**.

[0014] The profiler **100**, seen in enlarged form in **FIG. 3**, comprises a manifold **113** which is connected to a mounting plate **114**. The mounting plate **114** is connected adjacent the hydraulic motor **104** (**FIG. 4**). An arm **120** is connected to the mounting plate **114** and extends towards the operator **103** as seen in **FIG. 1**. At the end of the arm **120** remote from the mounting plate **114**, a distance sensor **121** is provided to measure the distance of the sensor **121** from the surface of the ground formation **122** into which the screw anchor **112** is installed. The distance sensor **121** may be any one of a number of different known designs, conveniently an optical ranging sensor or an acoustical ranging sensor. As the screw anchor **112** is rotated further into the ground **122** under the influence of hydraulic motor **104**, the distance sensor **121** senses the reduced distance and provides this distance information to the operator **103** through direct or indirect readout information such as by way of a PDA or laptop screen **151** (**FIG. 6**) or by way of an instrument display **150** mounted to be visible to the operator **103**.

[0015] The profiler **100** further includes a sensor attachment **123** (**FIG. 3**) which is connected to the mounting plate **114** and the hydraulic manifold **113**. The sensor attachment **123** includes two pressure sensors **130**, **131**, pressure sensor **130** being used to measure the inlet hydraulic pressure to the hydraulic motor **104** (**FIGS. 1, 2** and **4**) and pressure sensor **131** being used to measure the outlet hydraulic pressure from the hydraulic motor **104**. The differential pressure between the inlet and outlet sensors **130**, **131**, is thereby obtained and by extrapolating this information with known torque values for the particular hydraulic motor **104**, a value for the torque being applied to the screw anchor **112** by the hydraulic motor **104** may be obtained.

[0016] A tilt sensor **132** (**FIG. 3**) is likewise conveniently included within the sensor attachment **123**. The tilt sensor **132** may be either a one or two axis tilt sensor. It provides the operator **103** with an indication of the orientation of the screw anchor **112** while the screw anchor **112** is being installed or rotated within the ground formation **122**.

[0017] A controller (**FIG. 6**) in the form of an embedded microprocessor controller **133** is provided which receives the real time information from the various sensors, namely pressure sensors **130**, **131**, distance or range sensor **121**, and tilt or inclinometer sensor **132** and converts the information to read out information which the operator **103** may view by way of instrument display **150**, laptop or PDA screen **151**, to assist the installation of the screw anchor **112**.

Operation

[**0018**] In operation, the screw anchor **112** intended to be installed into the ground formation **122** will be connected to a drill head **134** through a shear pin release assembly **125** which is connected to drill head **134** which is rotated by hydraulic motor **104** (**FIG. 4**). The operator **103** will manipulate the boom **102** (**FIG. 1**) to position the screw anchor **112** in its desired initial position prior to rotation into the ground formation **122**. When that position is reached and with the end of the screw anchor **112** at or near its desired initial drilling position, the operator **103** will view the real time information from orientation sensor **132** and manipulate the boom **102** in order to ensure that the foundation support **112** is in its desired initial orientation, i.e, vertical, for example, in the specific embodiment described. When that position is reached, the operator **103** will initiate rotation of the screw anchor **112** into the ground formation **122** by providing hydraulic pressure to the hydraulic motor **104** from hydraulic pump **110** (**FIG. 2**).

[**0019**] It is known that the screw anchor **112** will provide sufficient support for a certain foundation **140** (**FIG. 1**) when the torque applied to the screw anchor **112** during installation reaches a certain value; that is, for a certain application, if the screw anchor **112** is to bear a load of a predetermined weight, say the weight of a typical failed foundation for a medium sized residence, the torque required may be 4000 ft.lbs. which will be reached when, for example, the screw anchor **112** reaches a depth of approximately fifteen (15) feet. The operator **103**, therefore, will continue to rotate the screw anchor **112** until the torque indicated on the real time read out display reaches that value at which point the screw anchor **112** will be in its installed position and the foundation **140** may be connected to and raised or lowered relative to the screw anchor **112**. One or several screw anchors **112** may be used, there being couplings **135** connecting the successive screw anchors **112** until the desired value for the torque is reached. It typically is the case that as the screw anchor **112** moves deeper into the ground formation **122**, the torque necessary to rotate the screw anchor **112** will increase.

[**0020**] As the torque applied by the hydraulic motor **104** increases, the screw anchor **112** will move deeper into the ground formation **122**. The distance or range **121** will indicate the real time decrease of distance between the drill head **134** and the ground formation **122**. A graphical interface **150** (**FIG. 5**) which may be conveniently viewed, for example, on an instrument display **150** adjacent the operator **103**, will indicate to the operator **103** the distance traveled by the drill head **134** and, therefore, the screw anchor **112**. The real time value of the torque being applied to the screw anchor **112** by the hydraulic motor **104** may also be viewed. As the screw anchor **112** moves deeper into the ground formation **122**, the torque will necessarily and usually show a rise in value towards the desired "set point" for the screw anchor **112**.

[**0021**] When the drill head **134** reaches a position near the surface of the ground and the desired torque value for torque being applied to the screw anchor **112** has not yet been reached, the drill head **134** and shear pin coupling **125** will be disconnected from the screw anchor **112** may be connected to the top of the first screw anchor **112**. The operator **103** will then manipulate the boom **102** upwardly to a position wherein the second screw anchor **112** may be rotated downwardly into the earth formation **122**, while viewing the real time information from the orientation sensor **132** which ensures the operator is correctly positioning the screw anchor **122** for installation. The range sensor **121** will be reset to its initial setting corresponding to the new initial drilling position. Following the initiation of the operation of the hydraulic motor **104**, the installation operation of the screw anchor **112** will proceed in a manner similar to that described.

[**0022**] When the desired value for the torque applied to the hydraulic motor **104** is reached, the operation of the hydraulic motor **104** will be terminated. The attachment of the foundation **140** to the screw anchor **112** will proceed as is known.

[**0023**] Reference is now made to **FIG. 5** which illustrates a typical graphical display that might be generated for the use of the operator **103** or for subsequent analysis of the installation procedure of the screw anchor **112** by third parties.

[**0024**] The upper graph "A" illustrates the torque being applied to the screw anchor **112** by the hydraulic motor **104** in real time and as sensed by the torque sensors **130**, **131** already described. The center graph "B" indicates the distance measured by the range sensor **121** during the installation of the screw anchor **112**. The lower graph "C" indicates the net depth reached by the screw anchor **112** during installation. It will be seen that the torque increases as the measured distance between the drill head **134** and the surface **122** of the ground decreases; that is, as the screw anchor **112** screw sinks deeper into the ground formation. The torque is shown to cease at a certain distance measured "D". At this point, a second screw anchor **112** is connected to the first screw anchor **112** already drilled into the ground formation **122**. The drill head **134** is raised to accommodate the second screw anchor **112** and the torque again commences at "E" and continues to increase until the second screw anchor **112** is sunken fully into the ground formation **122**. At this point, the operator **103** determines that the first and second screw anchors **112** must be removed in favor of a different screw anchor **112**. Thus, the torque is reversed at "F" and becomes negative. The distance between the drill head **134** and ground surface **122** increases as the second screw anchor **112** is removed from the earth and, subsequently, the first screw anchor **112** is removed. At this point "G", the net depth will be zero on the ordinate of the lower graph "C". The new screw anchor **112** is then positioned in place and the operator **103** recommences to drill the new screw anchor **112** into the ground formation **122** at "H" as described earlier. When the set point (SP) is eventually reached for the desired value, as illustrated in the graph "A", the drilling is completed. The net depth of the screw anchor **112** will be seen in the lower graph of **FIG. 5** at "J".

[**0025**] Many modifications will readily occur to those skilled in the art. For example, while the orientation of the screw anchor **112** is usually vertical and, indeed, is vertical during the drilling operation described, the screw anchor **112** may be installed at any angle that is useful to accomplish the installation. For vertical ground interfaces, the installation of the screw anchor **112** may be horizontal and screwed into the ground formation **122** until the desired value for torque is reached.

[**0026**] Although the motor **104** being utilized conveniently is a hydraulic motor, it will be appreciated that the teachings of the present invention would likewise apply to alternative drive systems such as electric and pneumatic motors.

[**0027**] Many further modifications will readily occur to those skilled in the art to which the invention relates and the particular examples provided herein are illustrative of the invention only and should not be taken as limiting its scope as defined in accordance with the accompanying claims.

I claim:

1. Profiler for installation of foundation supports such as screw anchors and screw piers, said profiler comprising a first sensor to measure inlet pressure to a hydraulic motor used to rotate said screw anchor, a second sensor to measure outlet pressure from said hydraulic motor, said first and second sensors being utilized to determine torque being applied to said screw anchor by said hydraulic motor, a third sensor to measure the distance traveled by said screw anchor in an earth formation and means for comparing said distance traveled by said screw anchor with said torque applied to said screw anchor over said distance.

2. Profiler as in claim 1 and further comprising an orientation sensor for determining the orientation of said foundation support.

3. Profiler as in claim 1 as in claim 1 wherein said first and second sensors are hydraulic pressure transducers.

4. Profiler as in claim 2 wherein said orientation sensor is an axis sensor.

5. Profiler as in claim 4 wherein said axis sensor is a one axis sensor.

6. Profiler as in claim 4 wherein said axis sensor is a two axis sensor.

7. Profiler as in claim 1 wherein said distance sensor is an acoustic ranging sensor.

8. Profiler as in claim 1 wherein said distance sensor is an optical range sensor.

9. Profiler as in claim 1 wherein said pressure differential correlated with said hydraulic motor determines said torque.

10. Method of installing a screw anchor comprising applying a torque to said screw anchor by a motor connected to a drill head, allowing said screw anchor to move into a ground formation under the influence of said torque, determining the value of said torque applied to said screw anchor while said screw anchor moves into said ground formation and comparing the torque applied to said screw anchor with the distance traveled by said screw anchor in said ground formation.

11. Method as in claim 10 wherein said motor is a hydraulic motor.

12. Method as in claim 11 wherein said motor is an electrical or pneumatic motor.

13. Method as in claim 11 wherein said torque from said hydraulic motor is determined by pressure sensors.

14. Method as in claim 10 and further comprising monitoring the orientation of said support with an orientation sensor during said application of said torque.

15. Method as in claim 10 wherein said comparison is done in real time.

* * * * *