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PATENT SPECIFICATION

DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

Improvements in Rotary Ground Boring Apparatus

We, THE CEMENTATION COMPANY LIMITED, a British Company, of 20 Albert Embankment, London, S.E.1, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement.—

This invention relates to rotary ground boring apparatus for sinking and holding open large-diameter deep holes in earth or soft rock for foundation purposes or the like.

The design of such apparatus commonly involves the problem of supporting the walls of the hole, whilst transmitting heavy torques from a driving means to boring tools, without at the same time overloading the transmission equipment or impeding the removal of debris from the vicinity of the boring tools. Ready access to the tools for maintenance purposes is also required as well as provision for firm directional guidance.

It is known, in rotary ground boring apparatus, to apply torque to boring tools by means of a heavy bar which is axially aligned with the hole to be bored and which can be lowered and raised in relation to a mounting structure for feeding and withdrawing the boring tools. It is also known to transmit a rotary drive to such bar through a yoke which permits the aforesaid lowering and raising of the bar and which is itself rotated by a ring gear driven from a suitable power source. Such known apparatus does, however, have certain disadvantages in that the boring bar is somewhat difficult to guide accurately, does not provide support for the walls of the hole and also has to be withdrawn from the hole at frequent intervals to permit the discharge of accumulated debris. If the bar is made strong enough to resist the heavy torsional loads arising from an accidental jamming of the boring tools in hard or sticky ground, the gear required to raise it from the hole also becomes excessively cumbersome.

A main object of the present invention is to provide a generally improved rotary ground boring apparatus which is capable of obviating the aforementioned disadvantages of the known apparatus.

Accordingly, the invention provides a rotary ground boring apparatus in which boring means is arranged to receive rotary torque from a drive mechanism secured to a supporting framework wherein the framework is provided with power operated extensible and contractable ground bearing members, the operation of which can be co-ordinated, and wherein the boring means incorporates a hollow ground-supporting bar or casing arranged for adjustable connection to the drive mechanism by releasable clamping means so as to be rotatable by said mechanism and axially movable by operation of the ground bearing members, and a boring tool or bucket which can be lowered inside the bar or casing and is arranged for adjustable location therein by releasable gripping means whereby rotational and axial movement of the bar or casing can be transmitted also to the boring tool or bucket.

By employing boring means composed of a hollow bar or casing which may perform a boring function as well as serving to support the wall of the hole being bored and which receives the drive from the rotary drive mechanism, and a boring tool or bucket which in turn receives a drive from the hollow bar or casing, it becomes possible to excavate whilst the bar or casing continues to be driven. This, of course, offers considerable advantages over apparatus which has to cease boring whilst the casing is inserted and thereafter bores in or through the casing.

The use of adjustably-retractable and extensible ground bearing members also enables the entire framework to be raised or lowered to feed or withdraw the boring tool and casing. Such an arrangement has the added advantage of providing heavy tool moving forces which

are occasionally required, especially when extracting the hollow bar or casing, and also enables the framework to be raised clear of the hole opening in order to give better access for concrete pouring equipment and the like. The ground bearing members conveniently are composed of a number of hydraulic leg rams or jacks which may be operated independently, to facilitate initial levelling of the machine, or in unison to maintain orientation during operation.

In order that the invention may be clearly understood and readily carried into effect, an embodiment thereof will now be described in detail with reference to the accompanying drawings, in which:—

Figure 1 is a partially diagrammatic part-sectioned side elevation showing an assembled rotary ground boring apparatus constructed in accordance with the invention,

Figure 2 is a diagrammatic view of hydraulic circuits in a hydraulic drive employed for rotating and axially displacing a boring means,

Figure 3 is an enlarged side elevation showing a typical framework with extensible ground bearing members for a rotary ground boring apparatus of the invention, the ground bearing members being shown extended in chain-dotted lines,

Figure 4 is a plan view corresponding to Figure 3,

Figure 5 is a vertical diametral section through part of the framework according to Figures 3 and 4,

Figure 6 is a part-sectional plan, also to an enlarged scale, and shows an arrangement for transmitting a rotary drive from a circular-section hollow bar or casing to a bucket or boring tool, and

Figure 7 is a diametral vertical section on the line A—A of Figure 6.

The partially diagrammatic embodiment of a rotary ground boring apparatus shown in Figure 1 employs boring means incorporating a hollow bar or casing 31 of circular-section which may have cutting tools at the lower end for performing a boring function and which also serves to support the ground around the hole being bored. The bar or casing 31 in this embodiment is arranged to extend slidably and rotatably through a centre opening in a round driving table which has a ring gear 34 around the periphery thereof and a dependent tubular extension 35 around the centre opening. The driving table is rotatably mounted in a framework 36 and is held against axial movement relative to the framework by the inter-engagement of appropriate bearing surfaces which are not shown on the diagrammatic drawing. The rotary driving table is arranged to receive a drive from motors 37 via gear wheels 38 which mesh with the ring gear 34. As can be seen, the motors 37 are mounted on the frame 36 and may be supplied

by additional similarly mounted motors if so desired.

The frame 36 is supported by adjustably retractable and extensible ground bearing members conveniently in the form of legs or jacks 39 which may be mechanically or hydraulically operable. The jacks 39 are capable of raising or lowering the frame 36 as required.

In order to couple the driving table with the circular-section bar or casing 31, a hydraulically operable clamping or clutch means 40 incorporating a plurality of hydraulic piston and ram assemblies 41 is arranged around the tubular extension 35 of the driving table and is operable to exert radial pressure at any required location along the length of the bar or casing. Thus, with the clamping means engaged, a rotary drive from the motors 37 is transmitted to the driving table through gearing 38 and 34 and thence through the tubular extension 35 and the clamping means 40 to the bar or casing 31. When the clamping means is engaged the bar or casing is held against axial movement in relation to the table and framework, and axial movement of the bar or casing is then accommodated by raising or lowering the jacks 39.

A bucket or boring tool 42, which may have the form of an auger as shown and which also forms part of the boring means, is lowered inside the bar or casing 31 on a rope 43 suspended from any conventional type of crane or hoist 44. In order to provide a rotary drive from the bar or casing 31 to the bucket or boring tool 42, gripping means 45 is provided, such means being carried by a square-section bar 46 which also carries the bucket or boring tool 42. The gripping means is operative to exert outward bearing pressure on the inside of boring bar 31 as will later be explained in more detail.

With the arrangement described, it will be appreciated that, by gripping the bucket or boring tool to the bar or casing and by clamping the bar in turn to the driving table and thus also the framework, the full lifting force of the jacks 39 may be employed to assist the raising of the bucket or boring tool if the latter becomes trapped by moving or sticky ground, or if such assistance is required for any other reason. The axial driving force applied to the bucket or boring tool will also be reinforced by the weight of the entire framework and driving motors when the jacks are lowered.

Power for rotating a hollow bar or casing and thus also a boring tool or bucket may be supplied electrically, pneumatically or hydraulically. In Figure 2 a preferred form of hydraulic drive is shown diagrammatically, such drive incorporating means to prevent damaging torques being generated in the event of the bar or casing or boring tool encountering an obstruction. The hydraulic circuit incor-

porates one or more hydraulic motors 49 similar, for example, to the motors 37 shown in Figure 1, supplied by a variable-delivery pump 50 driven by diesel, petrol, electric or other prime mover 51. A control shaft 52 regulating the delivery of pump 50 is operated by a piston and cylinder 53 connected by a conduit 54 dividing through non-return and check valves 55 and 56 to join both supply and return conduits 57 and 58 of the main hydraulic circuit. The pressure in main conduit 57 will exceed that in main conduit 58 or vice versa depending upon the sense of the rotation of motor 49. In either case, the excess pressure will be transmitted via check valve 55 or 56 to conduit 54 and thence to cylinder 53. Excess pressure will be related directly to the torque generated by motor 49. Pressure supplied to cylinder 53 is arranged to move control rod 52 in such a way as to reduce the delivery of pump 50 and to stop delivery in the event of the excess pressure exceeding a pre-determined value. For this purpose spring or other means acting to return the control rod 52 is provided in order to restore delivery when the excess pressure is diminished. The arrangement acts, therefore, to reduce speed as torque increases and vice versa.

In a more elaborate form of control, a branch 59 is added to conduit 54 as shown in dotted lines in order to take control pressure to a second hydraulic transmission system operating the lowering equipment (i.e. the jacks) for the bar or casing. In that circuit, a variable delivery pump 60 supplies fluid to a motor 61 powering the lowering equipment. The control branch 59 is led to a cylinder 62 operating control rod 63 which in turn operates pump 60 substantially in the same manner as described for pump 50. Increasing excess pressure in one or other of the driving system main conduits 57 and 58 is applied to cylinder 62 so as to operate control rod 63 and diminish the output of pump 60 thus reducing the speed of motor 61 and causing the speed of lowering of the bar or casing to be reduced. This serves to diminish the forces resisting rotation of the bar or casing. Both automatic control systems may be overridden by manual controls.

Figures 3, 4 and 5 of the drawings illustrate a practical form of a framework, ground bearing members and rotary driving means which have previously been illustrated in partially diagrammatic form in Figure 1. In these three Figures a framework 64 is shown supported by ground bearing members in the form of hydraulic jacks 65 having extensible pistons 66 terminating in foot plates 67. Spikes, not shown, may also be arranged to project below the foot plates 67 and eyes 68 for the attachment of a hoist rope are conveniently provided at the upper ends of the jacks.

The framework 64 rotatably carries a driving table 69 which forms part of a rotary

drive mechanism incorporating hydraulic motors 70 mounted on the frame structure 64. The motors 70 drive the table through a ring gear 71 (Figure 4) secured around the table rim and gear wheels which mesh with the ring gear in a manner similar to that shown in Figure 1. The bearing arrangement for the table 69 in the framework 64 is such that the table can rotate freely but is held by bearing surfaces against axial movement relative to the framework. A tubular extension 72, which projects downwardly from the table, aligns with a centre opening 73 through the table and is arranged to receive a circular section hollow bar or casing so that the latter is free to move axially and rotationally in the table opening 73 and tubular extension 72 thereof.

In order to clamp the hollow boring bar against both rotary and axial movement relative to the table, a releasable clamping or clutch means is provided which is operable to apply a radial gripping force to the hollow bar or casing at any position along the length thereof. When the bar or casing is thus gripped by the clamping means, rotation of the table will be transmitted to the bar or casing which will in turn be caused to rotate with the table. Since the bar or casing is held against axial movement in relation to the table, it is necessary to operate the jacks 65 to accommodate axial feed and withdrawal movement of the bar or casing in conjunction with movement of the entire framework 64 and table 69.

The releasable clamping means in this embodiment consists of a plurality of radially disposed rams 74 which are mounted circumferentially around the tubular extension 72 of the driving table, and have pistons 75 which protrude radially through holes 76 formed in the wall of the tubular extension. The inner ends of the pistons 75 are thus operative to clamp the bar or casing when the latter is located in an operative boring position by the driving table. The pistons 75 may be covered with friction material in order to enhance their grip. Power for the hydraulic rams is conveniently provided by a small hydraulic power pack 76a which is also mounted on the tubular extension 72 and is driven by an electric motor. In order to supply electricity to the motor, brushes 77 and 78 are arranged to bear against slip rings 79 and 80 which encircle the tubular extension 72 of the table, the brushes 77 and 78 being located on the stationary framework 64. A third slip ring 81 with a co-operating brush 82 may also be added for the purpose of conveying electric control signals to the moving parts of the apparatus.

In Figures 6 and 7 there is shown a practical form of the gripping means 45 indicated in Figure 1 whereby a rotary drive can be transmitted from a hollow bar or casing to a boring tool or bucket located within or projecting beyond the bar or casing. In principle, the



gripping means is arranged to provide a small initial grip as a result of movements which take place on relaxation of the crane rope (such as 43, Figure 1) when the boring tool or bucket touches the bottom of a hole. Thereafter the grip is magnified by the driving torque transmitted from the hollow bar or casing.

The gripping means incorporates segments 83 carrying friction pads 84 and arranged so as to be thrust radially outwards in order to bear against the inner cylindrical surface of a circular-section hollow bar or casing such as is shown at 31 in Figure 1. For this purpose, each segment 83 is carried on a toggle link assembly 85 having one end hinged or pinned to the segment at 86 and the other end hinged or pinned to a common central frame 87. The frame 87 is mounted for limited sliding movement upon a square-section bar 88, which corresponds with the bar 46 of Figure 1, for the purpose of transmitting torque to a boring tool which is not shown in Figure 6 but which will be locked to the bar 88. This boring tool may, of course, be in a form similar to the bucket or auger 42 of Figure 1. The frame 87 is also provided with peripheral recesses 89 arranged to bear against protrusions 90 on the segments 83 in order to limit the movement of these segments.

Also carried on bar 88 is a disc 91 having a frusto-conical outer rim surface 92 in slidable contact with complementary sloping surfaces 93 attached to the segments 83. Relative sliding movement takes place between these surfaces on slackening of a hoist cable, such as 43 shown in Figure 1, which is attached to eyes 94 secured to the top of member 87. The slackening of the hoist cable, which takes place when the boring tool touches the bottom of the hole, allows member 87 to slide down the bar 88 with corresponding sliding movement of surfaces 93 over surface 92. The result is to thrust each segment 83 radially outwards until the pads 84 engage the inner surface of the hollow bar or casing. Rotation of the bar or casing in a clockwise sense as viewed in Figure 6 will then drag the pads 84 and the segments 83 in a similar direction relative to the frame 87. This causes the link assemblies 85 to exert a toggle action and to thrust segments 83 more firmly outwards to enhance the clamping action of the pads 84 against the inside surface of the bar or casing. The reaction of the links upon the frame 87 produces a turning action which is transmitted via the bar 88 to the boring tool also attached to bar 88 as aforesaid. Any tendency of the segments to turn too far in a clockwise sense will cause the protrusions 90 thereon to engage the recesses 89 in the frame 87 before the toggle action of the links 85 is lost.

To release the gripping means the direction of rotation of the bar or casing is reversed causing the segments 83 to retract. Tension springs 95 between the links 85 and the frame

87 are provided to assist retraction. Subsequent lifting of the device by the hoist rope attached to eyes 94 causes the surface 93 to slide up the conical surface 92 and permit further retraction of the segments 83.

WHAT WE CLAIM IS:—

1. A rotary ground boring apparatus in which boring means is arranged to receive rotary torque from a drive mechanism secured to a supporting framework wherein the framework is provided with power operated extensible and contractable ground bearing members, the operation of which can be co-ordinated, and wherein the boring means incorporates a hollow ground-supporting bar or casing arranged for adjustable connection to the drive mechanism by releasable clamping means so as to be rotatable by said mechanism and axially movable by operation of the ground bearing members, and a boring tool or bucket which can be lowered inside the bar or casing and is arranged for adjustable location therein by releasable gripping means whereby rotational and axial movement of the bar or casing can be transmitted also to the boring tool or bucket.

2. A rotary ground boring apparatus as claimed in claim 1 wherein the clamping means is arranged to grip the hollow bar or casing at any point along the length of said bar or casing.

3. A rotary ground boring apparatus as claimed in claim 1 or claim 2, wherein the gripping means is operable to secure the boring tool or bucket to the hollow bar or casing at any desired location along the length of the bar or casing.

4. A rotary ground boring apparatus as claimed in any of claims 1 to 3, wherein the rotary drive mechanism includes a driving table having an opening therethrough with an aligned downwardly projecting tubular extension for rotatably and slidably receiving the bar or casing, said drive table being rotatably mounted on the framework and being arranged to receive a rotary drive through gearing from at least one motor which is also mounted on the said framework.

5. A rotary ground boring apparatus as claimed in claim 4, wherein the releasable clamping means is in the form of hydraulic rams circumferentially spaced around the tubular extension of the table in alignment with holes through the tubular extension whereby the ram pistons can be caused to bear upon and grip an inserted bar or casing at the region along the length thereof which is located opposite said pistons.

6. A rotary ground boring apparatus as claimed in claim 5, wherein the rams are powered by a hydraulic power pack carried on the table and driven by an electric motor, electricity being supplied to the motor through slip rings on the drive table and co-operating brushes on the framework.



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To release the gripping means the direction of rotation of the bar or casing is reversed causing the segments 83 to retract. Tension springs 95 between the links 85 and the frame

87 are provided to assist retraction. Subsequent lifting of the device by the hoist rope attached to eyes 94 causes the surface 93 to slide up the conical surface 92 and permit further retraction of the segments 83.

WHAT WE CLAIM IS:—

1. A rotary ground boring apparatus in which boring means is arranged to receive rotary torque from a drive mechanism secured to a supporting framework wherein the framework is provided with power operated extensible and contractable ground bearing members, the operation of which can be co-ordinated, and wherein the boring means incorporates a hollow ground-supporting bar or casing arranged for adjustable connection to the drive mechanism by releasable clamping means so as to be rotatable by said mechanism and axially movable by operation of the ground bearing members, and a boring tool or bucket which can be lowered inside the bar or casing and is arranged for adjustable location therein by releasable gripping means whereby rotational and axial movement of the bar or casing can be transmitted also to the boring tool or bucket.

2. A rotary ground boring apparatus as claimed in claim 1 wherein the clamping means is arranged to grip the hollow bar or casing at any point along the length of said bar or casing.

3. A rotary ground boring apparatus as claimed in claim 1 or claim 2, wherein the gripping means is operable to secure the boring tool or bucket to the hollow bar or casing at any desired location along the length of the bar or casing.

4. A rotary ground boring apparatus as claimed in any of claims 1 to 3, wherein the rotary drive mechanism includes a driving table having an opening therethrough with an aligned downwardly projecting tubular extension for rotatably and slidably receiving the bar or casing, said drive table being rotatably mounted on the framework and being arranged to receive a rotary drive through gearing from at least one motor which is also mounted on the said framework.

5. A rotary ground boring apparatus as claimed in claim 4, wherein the releasable clamping means is in the form of hydraulic rams circumferentially spaced around the tubular extension of the table in alignment with holes through the tubular extension whereby the ram pistons can be caused to bear upon and grip an inserted bar or casing at the region along the length thereof which is located opposite said pistons.

6. A rotary ground boring apparatus as claimed in claim 5, wherein the rams are powered by a hydraulic power pack carried on the table and driven by an electric motor, electricity being supplied to the motor through slip rings on the drive table and co-operating brushes on the framework.

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7. A rotary ground boring apparatus as claimed in claim 3, wherein the boring tool or bucket is arranged for suspension by a hoist rope within the hollow bar or casing, the gripping means for locating the boring tool or bucket in the bar or casing being arranged for automatic initiation in response to movements which take place when the weight on the hoist rope is relieved by the boring tool or bucket touching the bottom of the hole.

8. A rotary ground boring apparatus as claimed in claim 7, wherein the gripping means includes a frame adapted for attachment to the hoist rope and arranged for limited axial sliding movement on a tool or bucket carrying bar, and segments carried around said frame and hinged to it by toggle links, each of said segments having an inclined surface adapted to engage a co-operating frusto-conical surface attached to the tool or bucket carrying bar whereby downward movement of the frame and segments under gravity, when the boring tool or bucket touches bottom as aforesaid, moves said segments outwardly initially to bear against the inside surface of the hollow bar or casing, the gripping action being subsequently magnified by the driving

torque received from the bar or casing and transmitted through the toggle links.

9. A rotary ground boring apparatus as claimed in claim 8, wherein the segments are arranged automatically to retract under the action of the toggle links when the direction of rotation of the hollow bar or casing is reversed, springs being connected between the links and frame to assist said retraction.

10. A rotary ground boring apparatus as claimed in any of claims 1 to 9, wherein the ground bearing members supporting the framework consist of jacks arranged for hydraulic operation either individually, for initial adjustments, or in unison for lowering or raising the boring apparatus.

11. A rotary ground boring apparatus substantially as hereinbefore described and illustrated with reference to Figures 1 to 7 of the accompanying drawings.

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