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(54) METHOD AND APPARATUS FOR FORMING FOUNDATIONS

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(57) **ABSTRACT**

A method of forming a foundation with a hollow-section reaming tube is described. The method includes drilling a pilot bore-hole to a required depth and reaming the pilot bore-hole by rotating the hollow section reaming tube which is subsequently not retracted. The hollow section reaming tube may comprise at least one tube section adapted to connect with another tube section via corresponding screw threads.

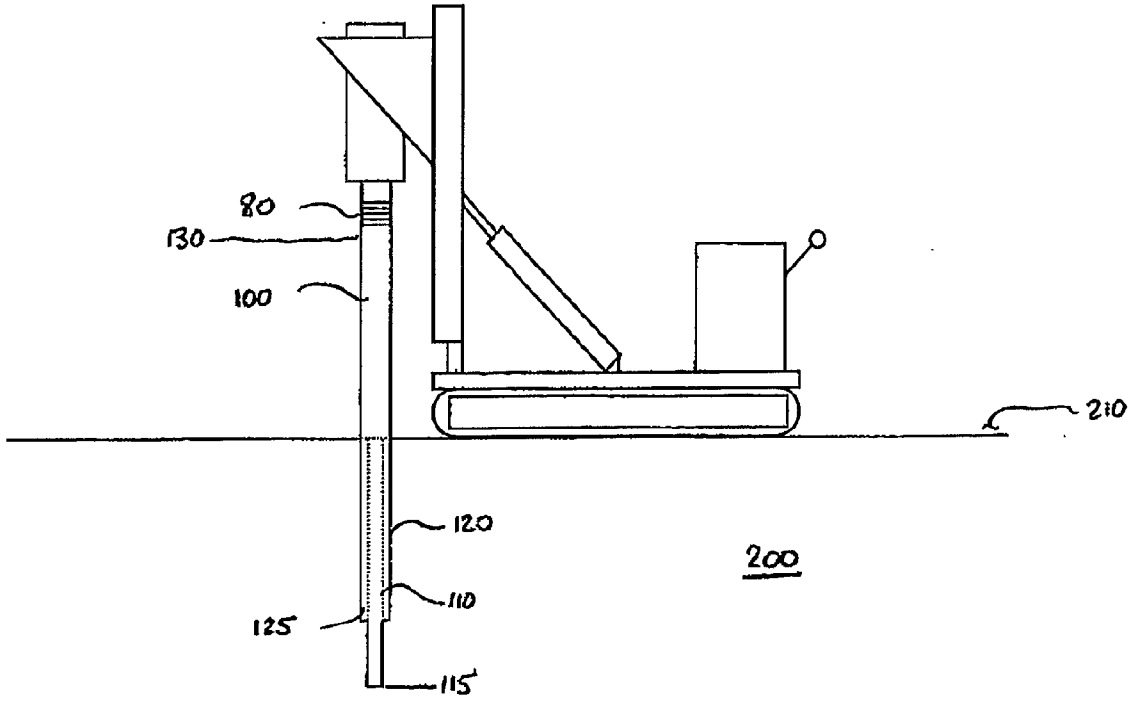


Fig. 1.

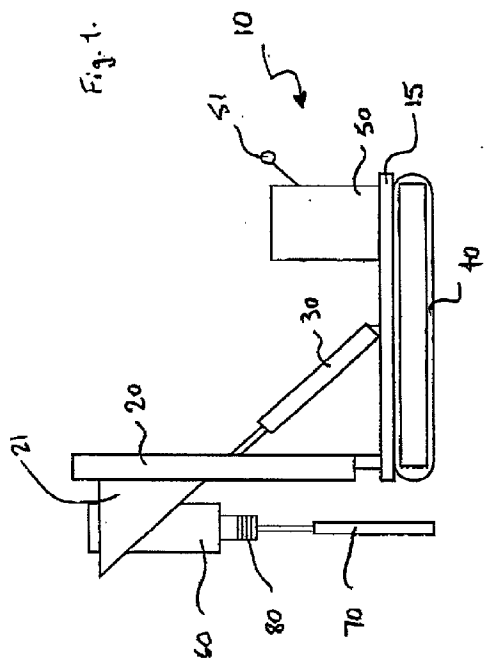


Fig. 2.

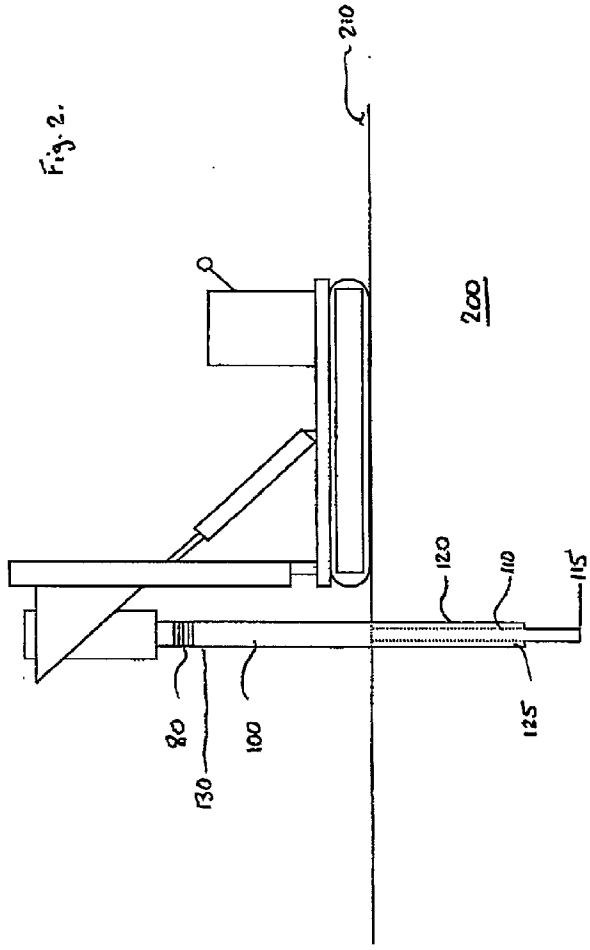


Fig. 4.

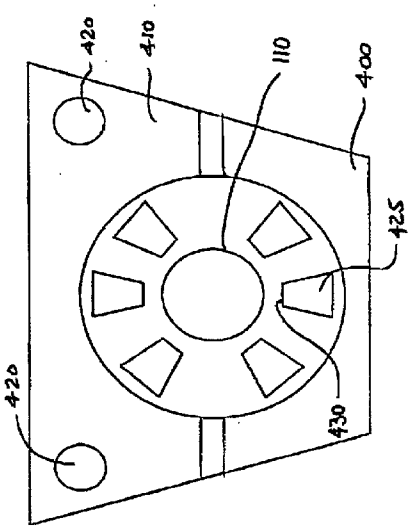
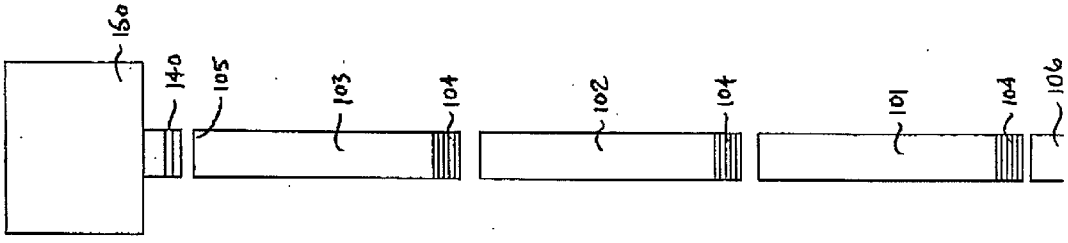

420
410
110
400
425
420
430

Fig. 3.


160
140
105
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102
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106

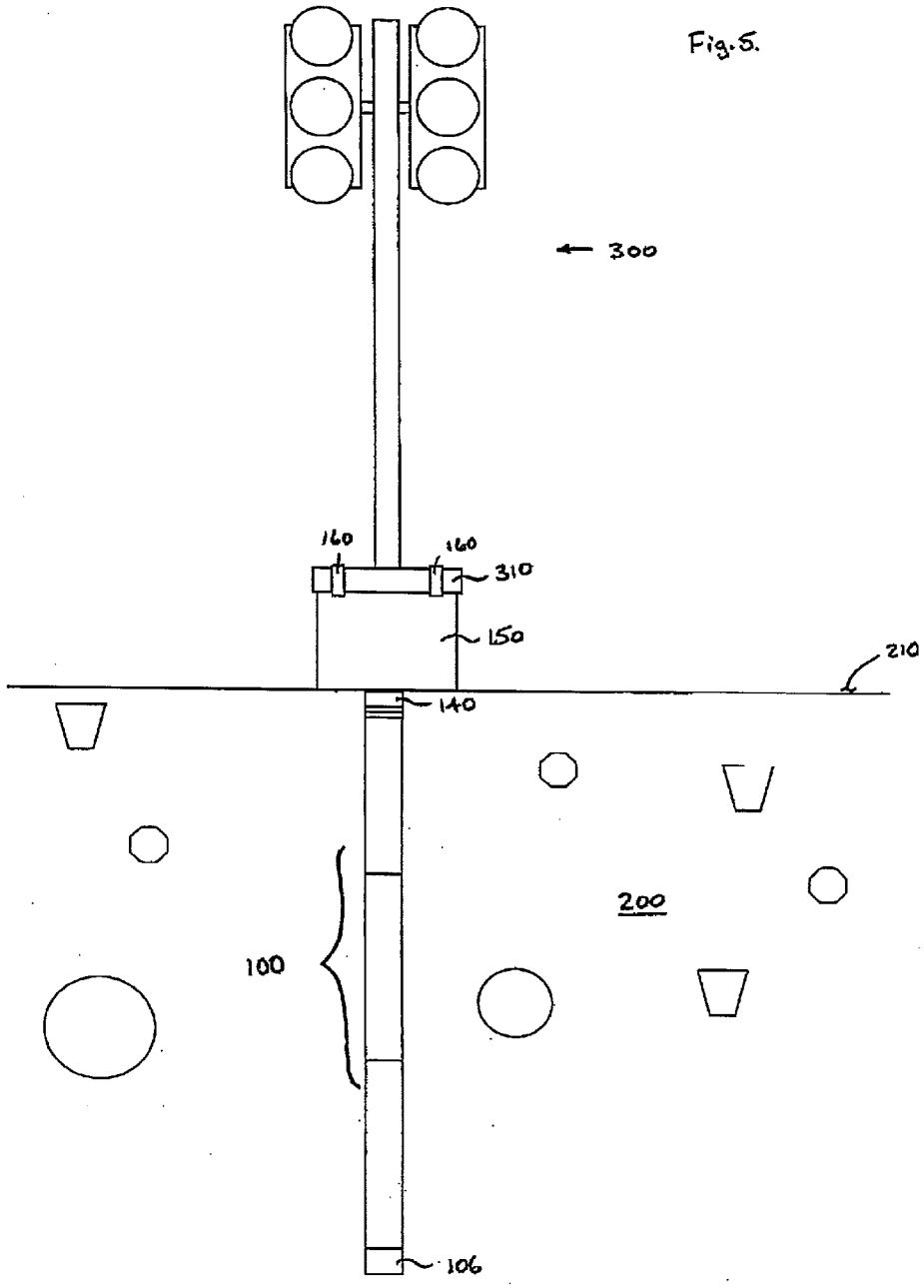


Fig. 5.

Fig. 6.

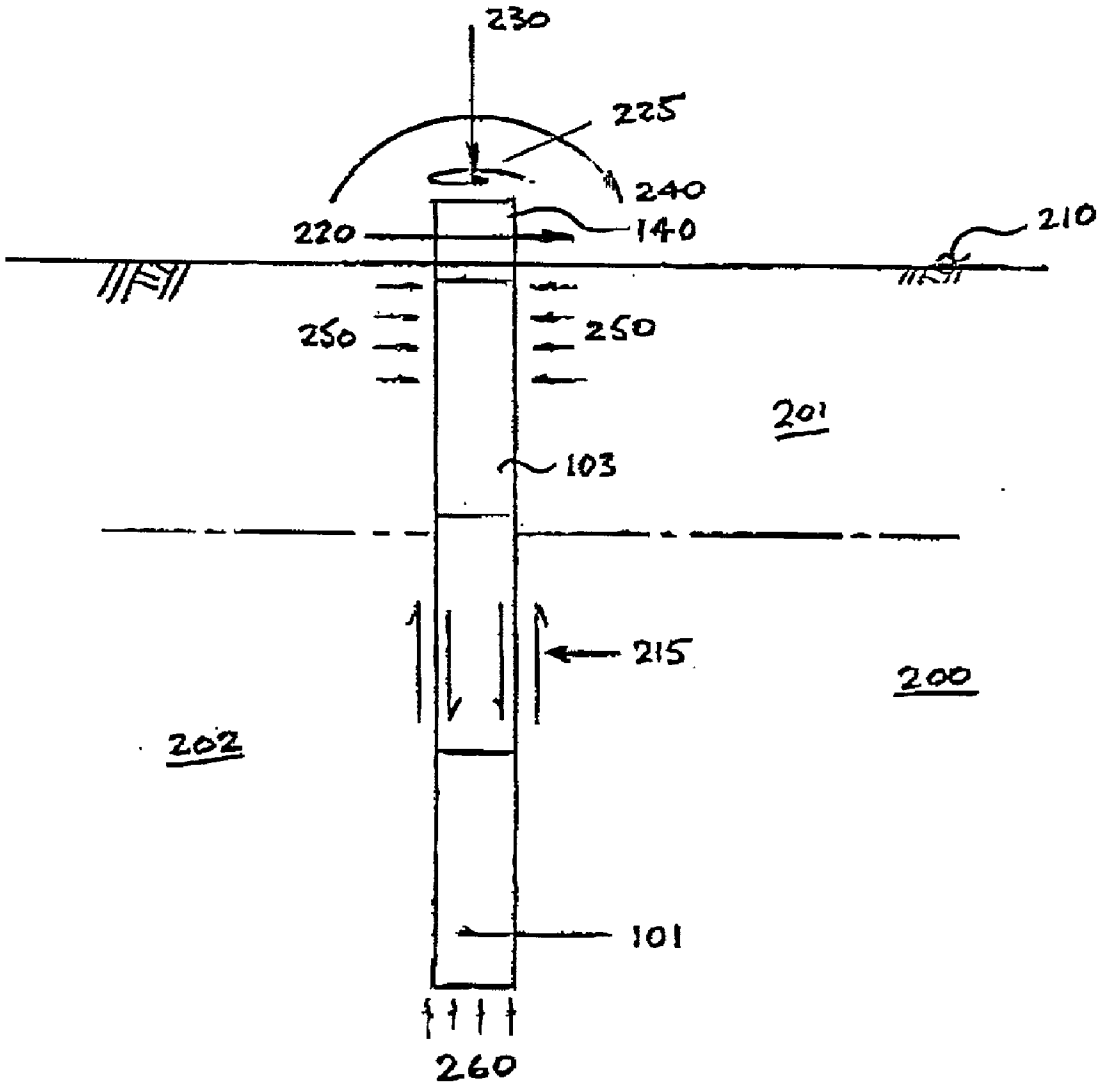


Fig. 8.

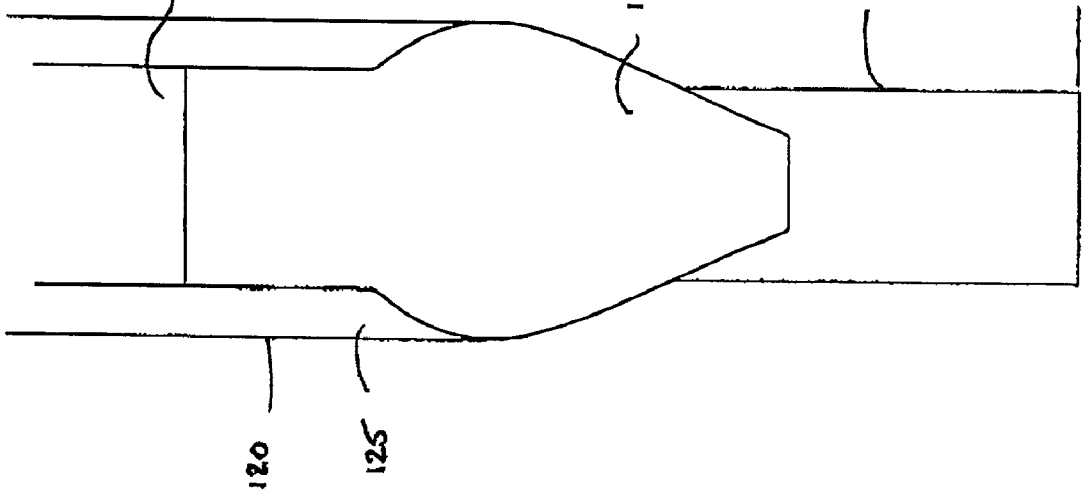
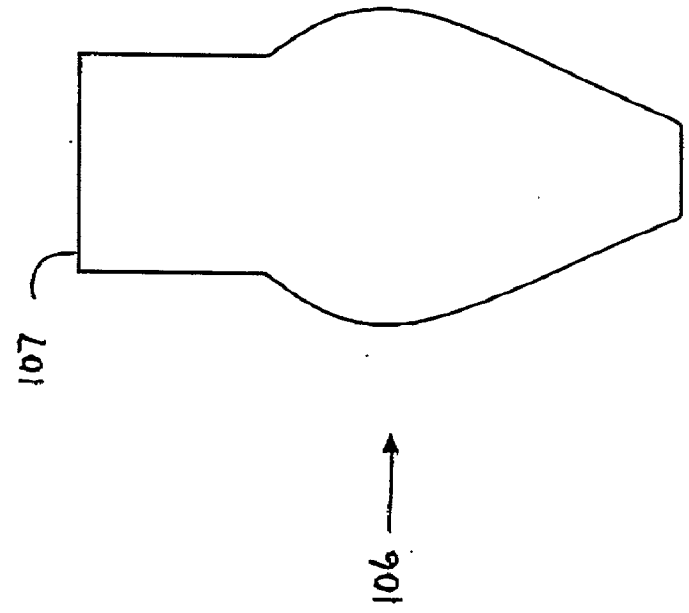


Fig. 7.



METHOD AND APPARATUS FOR FORMING FOUNDATIONS

BACKGROUND TO THE INVENTION

[0001] The present invention relates generally to forming foundations, and more particularly, but not exclusively, to the formation of foundations for the purpose of mounting railway signalling posts and the like thereto. Foundations formed according to the invention may, however, be used for many purposes, not just limited to railway applications, but also applications in many other industries, for example, highways, airports, civil structures. The foundations may be for a variety of superstructures, such as lighting columns, telecommunications masts, gantries, barriers, or other structures.

[0002] Conventionally, railway signalling posts have been scoured to a concrete plinth set within the ground adjacent to the railway tracks. A foundation bole once drilled is filed with concrete and this is capped-off with the concrete plinth. Once the concrete (or grout) has dried and hardened (usually after about 2 weeks) steel bolts which are set within the plinth are able to receive a base platform of the signalling post (or other such structure).

[0003] The problem with the above method is that it is a distinct three-stage process; the particular section of railway track must be closed to traffic on three separate occasions: when undertaking preliminary site investigation works, when drilling the foundation, and when pouring the concrete plinth. This is often a disruptive and highly costly process.

[0004] Consequently, it is desirable to have a method of erecting railway signalling posts and the like, in a single stage such that track closure is minimised but signalling post stability and integrity are maintained.

SUMMARY OF THE INVENTION

[0005] In accordance with an aspect of the present invention, there is provided a method of forming a foundation including the steps of: drilling a pilot bore-hole to a required depth; reaming the pilot bore-hole with a rotating hollow-section tube which is not retracted and remains in the ground; and securing a load-bearing mounting platform to the end of the tube.

[0006] The method preferably includes the steps of: reaming the pilot bore-hole with a hollow-section steel tube, comprising a plurality of tube sections which are interconnected via mutually mating screw threads; and mounting a signalling post to the load-bearing mounting platform.

[0007] In accordance with another aspect of the present invention, there is provided a foundation forming apparatus including: a hollow section reaming tube comprising at least one tube section adapted to connect with other tube sections via corresponding screw threads; a displacing tube section with an end shaped to displace material; a rotary mechanism for providing a torque to an end of the reaming tube distal from the displacing tube section; and a terminal tube section.

[0008] The terminal tube section preferably includes, or is adapted to receive, a load-bearing mounting platform.

[0009] The present invention further provides a method of forming a foundation, comprising the steps of rotating a hollow-section tube into the ground to form a support, and securing a load-bearing mounting platform to the end of the tube.

[0010] According to the present invention in a further aspect, there is provided an apparatus or method comprising any one or more of the novel features described herein.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] Embodiments of the present invention will now be described, by way of example only, with reference to the accompanying schematic drawings, in which:

[0012] **FIG. 1** is a side view of a drilling rig;

[0013] **FIG. 2** is a side view of the drilling rig of **FIG. 1** including a reaming tube;

[0014] **FIG. 3** is a partially exploded view of the reaming tube, terminal tube section and mounting platform;

[0015] **FIG. 4** is a plan view of a securing jig;

[0016] **FIG. 5** is a sectional view of a signalling post in place after installation;

[0017] **FIG. 6** is a schematic force diagram showing the lines of action on a reaming tube within the ground;

[0018] **FIG. 7** is an elevation view of a displacing tube section; and

[0019] **FIG. 8** shows the displacing tube section in operation.

DESCRIPTION OF THE PREFERRED EMBODIMENTS OF THE INVENTION

[0020] Referring to **FIGS. 1 and 2**, a drilling rig **10** includes a mast **20** and a platform **15** with a ram **30** connected therebetween. The rig is most preferably self-propelled.

[0021] Attached to the mast **20** is a rotary drive means in the form of a motor **60** for providing rotary power to an auger **70**.

[0022] The rig **10** can be manoeuvred via caterpillar tracks **40** and control means **50**. An operator controls the rig through manipulation of control levers **51**. The control means **50** can be mounted on the rig **10** as shown, or it maybe independent and remote from the rig but connected to the rig via a suitable control line.

[0023] The motor **60** is slidably supported on a jib element **21** which is adapted to traverse up and down the mast **20**, thus giving control over drilling depths. Again, movement of the jib **21** is controlled via the control means **50** and the levers **51**.

[0024] In a foundation installing operation, the rig **10** is manoeuvred into place until the auger **70** is positioned over the desired spot. A pilot hole **110** is then bored out to a desired depth (shown as **115** for convenience). Drilling a pilot hole enables investigation of the type and parameters of the material surrounding the location of the foundation site. The depth of the pilot hole depends on these parameters, and these are determined on site.

[0025] The auger **70** is withdrawn from the pilot hole, detached from the motor **60** and replaced with a rag tube

100. The reaming tube **100** is coupled to a screw thread **80** disposed on a lower portion of the motor. For clarity, the tube **100** is depicted as a single unit, whereas it will in general consist of a plurality of tube sections as shown in **FIG. 3**.

[**0026**] In an embodiment of the present invention, the reaming tube consists of several tubular steel sections of 1 m in length. Each tubular section has an external diameter of 220 mm, the internal diameter is dictated by the thickness of the outer wall of the tube; wall thickness will be determined by the strength of the tube required and corrosion rate analysis in a given application.

[**0027**] In one non-limiting example, a pilot bore-hole of diameter 185 mm will be sunk to the required depth. The reaming operation will then extend the diameter of the hole to 220 mm.

[**0028**] Each reaming tube section **101** to **103** has an outer screw thread **104** which mates with an internal screw thread **105** of an adjoining section. Alternatively, the tube segments can be joined by other means, such as clips, bolts, welds or others.

[**0029**] In operation, a displacing tube section **106** will act to displace the surrounding soil as it travels down the pilot bore-hole, see **FIG. 8**.

[**0030**] The reaming tube **100** is rotated downwards into the soil **200**, consequently reaming the pilot hole **110** (the diameter of which is less than the diameter of the reaming tube) by displacing the outer section **125** until the tube **100** reaches a desired depth **115**. At this stage (the diagram is not to scale for simplicity) the proximal end of tube section **103** will be at a particular specified level (eg ground level).

[**0031**] Rotating ("spinning") the reaming tube **100** into the ground in a cork-screw fashion has the advantage over the conventional technique of pile-driving (ie hammering), that the same plant equipment, ie rig **110**, is used for both pilot bore-hole drilling and the implanting of the foundation itself, namely, the reaming tube **100**.

[**0032**] To prepare a given foundation, only the rig and the relevant number of reaming tube sections are required; no pile-driving or concrete pouring equipment is needed. The tube **100** itself provides the foundation, no concrete, grout or other filler is necessary.

[**0033**] During operation, the rotary drive means **60** rotates the reaming tube **100** in a sense that tends to tighten the connection between the tube sections **101**-**103**. Furthermore, usually (but not always) a structural glue will be used to aid adhesion between adjacent tubes sections. A typical structural glue is an epoxy adhesive, an example of which is made by FEB Limited.

[**0034**] Lateral loads to the tube are resisted during insertion into the ground due to the rotation applied in the reaming process.

[**0035**] During rotation of the reaming tube, the displacing tube section **104** displaces the ground **200** surrounding the bore hole. There are no restrictions to the depth to which the tube may be sunk, or to the diameter of the tube itself.

[**0036**] During operation, as shown in **FIG. 8**, the displacing tube section **106** (bit **106**) enlarges the pilot bore-hole **110** to the larger diameter hole **120**. The displacing tube section includes an outer screw thread **107** for mating with thread sections **104**. Section **106** flares from a diameter equal to the diameter of the reaming tube to a diameter greater, and then tapers to a diameter which is less than the diameter of the pilot bore-hole **110**. This profile assists in displacing the soil surrounding the pilot hole.

[**0037**] An initial reamed area **125** is produced, of diameter roughly the same as the widest diameter of bit **106**. This exists for a short period only. After a certain time the soil at the circumference of the hole **120** will 'relax' back to a position where the soil and the outer surface of the reaming tube **100** are in close contact. The close contact between tube and soil gives rise to the adhesion forces **215**, as discussed above.

[**0038**] The displacing tube section **106** along with the entire reaming tube **100** remain buried in the soil.

[**0039**] In general, the number of tube sections **101** to **103** will depend on the nature and depth of the foundation required. An example might be to ream a 5 m bore hole using five 1 m tube sections.

[**0040**] Once the desired depth of hole has been reached, the motor **60** is detached from the ultimate tube section by reversing the motor and thus undoing the final internal screw thread **105** from the tread **80**.

[**0041**] A terminal tube section **140** is screwed into the exposed open end of the embedded reaming tube **100**; this will preferably have been pre-welded to a hollow, steel box section support platform **150**. Alternatively, the support platform may be secured to the tube, once the tube is in place in the ground. To this platform many types of structural posts and supports may be secured. In particular (as shown in **FIG. 5**), a track side railway signalling post **300** is bolted to the support platform **150**. Many different types of supports or heads can be affixed to the tubes in site. One example is a levelling screw baseplate connection. Baseplates will usually be mounted at approximately ground level.

[**0042**] In practice, signalling posts and the like will be secured to the platform **150** via heavy gauge mounting bolts **160** which are threaded through the signalling post base **310** and are anchored to the platform **150**.

[**0043**] **FIG. 6** shows a schematic diagram of the types of forces acting on the tube **100** in a typical foundation scenario.

[**0044**] The tube **100** is forced into the ground **200** by vertical load **230** assisted by an applied torque **225**.

[**0045**] For simplicity, the ground in the vicinity of the foundation site is split into an upper strata **201** and a lower strata **202**. These may be of different material, eg lower strata **202** may be generally clay-based, whereas upper strata **201** might be of lighter, sandy, material, for example.

[**0046**] Shear forces **220** are resisted by the lateral support forces **250** provided by the surrounding soil in strata **201**. Below this in strata **202** vertical load **230** (corresponding to the weight of the supported post) is resisted by adhesion forces **215** and end bearing forces **260**.

[**0047**] Furthermore, bending moments **240** are resisted by the lateral forces **250** in addition to the mechanical resistance of the hollow steel tube **103**.

[0048] **FIG. 6** includes the terminal tube section **140**.

[0049] Applied bending moments to this section are prevented form causing a hinge failure to sections below the ground level by the mechanical integrity of the hollow steel tube **100** and the lateral support forces **250**.

[0050] To facilitate firm and secure rotation of the topmost tube section during operation, a jig **400** is provided which sits above the pilot hole at ground level, see **FIG. 4**.

[0051] The jig **400** comprises a base plate **410** which is bolted to the ground over the hole via bolts **420**. The pilot hole **110** is surrounded by chuck-type jaws **425** whose inner most circumferential edge **430** delimits the reaming tribe diameter **120**.

[0052] As the successive sections **102** and **103** are inserted, the jig grips each section with sufficient pressure to allow the torque to be transferred downwards to the cutting end but also to prevent any slipping between thread **80** and section thread **105**.

[0053] In certain situations, it is envisaged that the pilot bore-hole and reaming operation will take place together with an auger preceding the reaming tube and then removed when the desired depth is reached, or alternatively the tube alone may be spun (rotated) into the ground without the necessity of a pre-bore.

[0054] Instead of using a displacing type bit, having a widened (bulged) portion, as described above, a cutting bit may be used.

[0055] The advantages of the present invention can be summarised as follows:

[0056] 1. The auger and steel reaming tube sections are preferably in easily manoeuvrable sections eg, but not necessarily, in the range of 250 mm to in excess of 3 m, preferably 1 m in length, to restrict the overall height of the operation.

[0057] 2. It is an all dry process therefore no curing time is required since there is no concrete or grout.

[0058] 3. Limited spoil to dispose of.

[0059] 4. Rapid installation.

[0060] 5. Manoeuvrable rig for sites and locations with restricted access.

[0061] 6. Permanent support to the ground during installation which prevents side collapse of the hole and possible vertical displacement at surface.

[0062] The tubes may be of any desired diameter and wall thickness.

[0063] Whilst the tubes are currently proposed to be of steel, or other metal, they may alternatively be of other materials, including, but not limited to, plastics materials, polymer, GRP, etc.

[0064] Where they are made of possibly corrosible material, then corrosion analyses can be made for each tube and corrosion protection can be provided, eg by cathodic protection, galvanising or by the use of other protective techniques or paint applications, as will be known in the art.

[0065] **4** In a variation, a plurality of tubes can be installed over an area, to support a common superstructure (ie several tubes support a single load-bearing platform).

[0066] Apparatus according to the invention may be connected to the hydraulic aim of a machine which is conventionally known as a road/railer machine, and which can then be used to make foundations according to embodiments of the invention.

What is claimed is:

1. A method of forming a foundation including the steps of: forming a bore-hole to a required depth; reaming the pilot bore-hole wit a rotating hollow-section tube which is not retracted and remains in the ground; and securing a load-bearing mounting platform to the end of the tube.

2. A method as claimed in claim 1, wherein the hollow-section tube is rotated into the ground.

3. A method of forming a foundation as claimed in claim 1 or **2**, wherein the method includes the step of reaming the pilot bore-hole with a hollow-section tube.

4. A method of forming a foundation as claimed in claim 1, **2** or **3**, wherein the hollow-section tube comprises a plurality of tube sections connected longitudinally.

5. A method as claimed in claim 4, wherein the plurality of tube sections are interconnected via mutually mating screw treads.

6. A method of forming a foundation as claimed in any preceding claim, wherein the hollow-section tube is steel tube.

7. A method of forming a foundation as claimed in any preceding claim, wherein a structure is mounted to the load-bearing mounting platform.

8. A method of forming a foundation as claimed in claim 7, wherein the structure is a signalling post.

9. A method of forming a foundation as claimed in any preceding claim, wherein the hollow-section tube includes an end shaped to displace material.

10. A method of forming a foundation as claimed in any preceding claim, wherein the pilot bore-hole is drilled using a mobile rig that includes an auger, and wherein the auger is removed prior to reaming and replaced by the hollow-section tube once the desired pilot hole depth has been reached.

11. A method of forming a foundation as claimed in any claim 1 to **9**, wherein the pilot bore-hole drilling directly precedes reaming by the hollow-section tube in a continuous operation, and wherein no intermediate auger replacement occurs.

12. A method of forming a foundation as claimed in any preceding claim, wherein a jig is secured over the pilot hole to facilitate firm and secure rotation of the hollow-section tube.

13. A method of forming a foundation as claimed in any of claims 5 to 11, wherein an adhesive is used to aid connection of tube portions.

14. A method as claimed in any preceding claim, wherein the bore hole is formed by the action of rotating the hollow section tube into the ground.

15. A method of forming a foundation, comprising the steps of rotating a hollow-section tube into the ground to form a support, and securing a load-bearing mounting platform to the end of the tube.

16. A foundation forming apparatus including: a hollow section tube comprising at least one tube section adapted to

connect longitudinally with other tube sections; a displacing tube section with an end shaped to displace material; a rotary mechanism for providing a torque to an end of the reaming tube distal from the displacing tube section; and a terminal tube section.

17. A foundation forming apparatus as claimed in claim 15, wherein the terminal tube section includes, or is adapted to receive, a load-bearing mounting platform.

18. A foundation forming apparatus as claimed in claim 16 or **17**, wherein the displacing tube section flares from a diameter equal to the diameter of the reaming tube to a diameter greater, and then tapers to a diameter less than the diameter of the reaming tube.

19 A foundation forming apparatus as claimed in any of claims 15 to 18, wherein the apparatus further includes a mobile jig including an auger, the auger being removable for replacement with the hollow section reaming tube prior to reaming, and wherein the mobile jig is adapted to operate in locations with restricted access such as railway track-side locations or highways.

* * * * *