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E1F FWB

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INT CL[7] **E02D 17/00 , E02F 3/00 , E21B**

(54) Abstract Title
Excavation apparatus

(57) A method of excavating the ground comprising positioning over the site to be excavated a support structure 2,3, the support structure 2,3 being provided with elongate excavator means 17 which is variable in length by extension or retraction and which carries a grab 18 or other excavation tool. The excavator means 17 is mounted on the support structure 2,3 so that it is movable relative to the support structure 2,3 within an operating region 1 above and including the said site. The excavator means 17 is movable relative to the support structure 2,3 within the operating region 1 by rotation about an axis passing through a mean point and by moving in a radial direction from the said mean point transverse to the said axis. The excavator means 17 is also capable of movement from within the operating region 1 to outside it along a predetermined path, to deposit material excavated from the site. Extension and retraction of the excavator means 17 and movement of the excavator means 17 within the operating region 1 and along the predetermined path is controlled from a position outside the operating region.

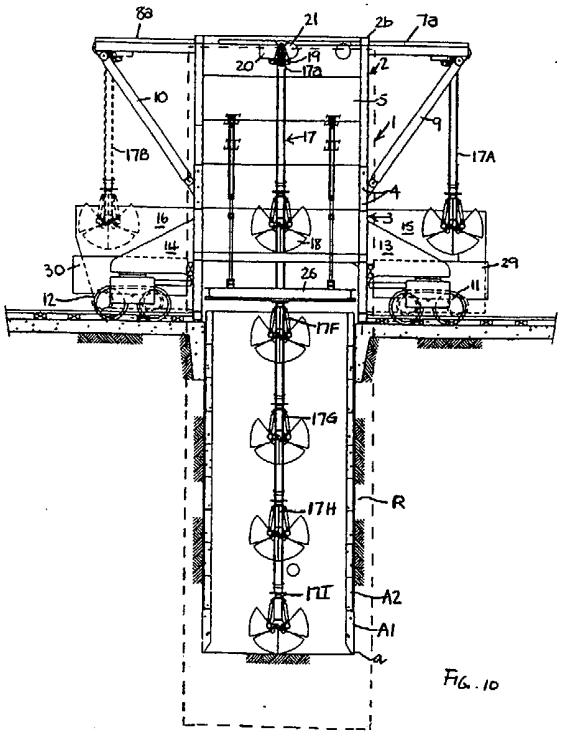

FIG. 10

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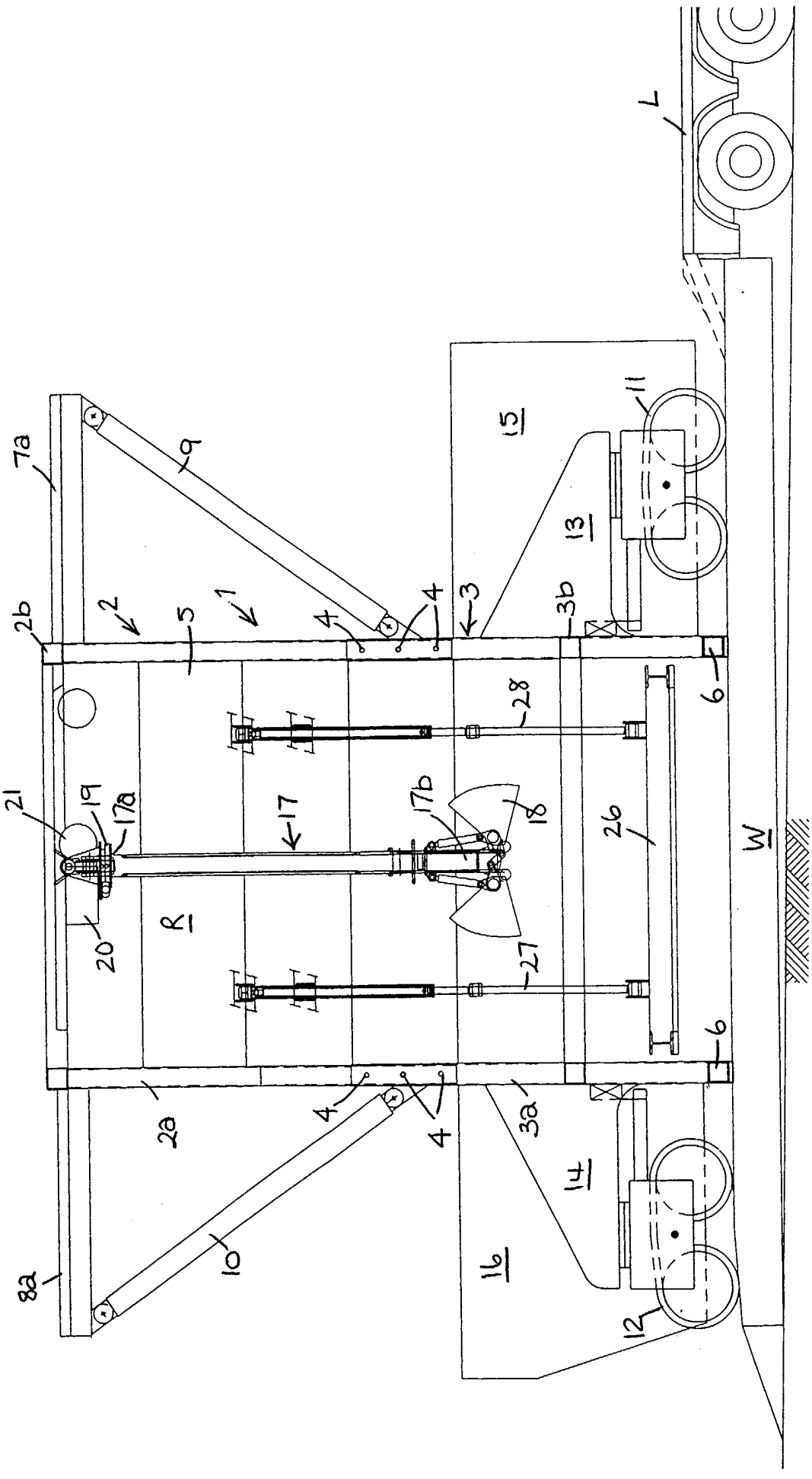
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FIG. 1

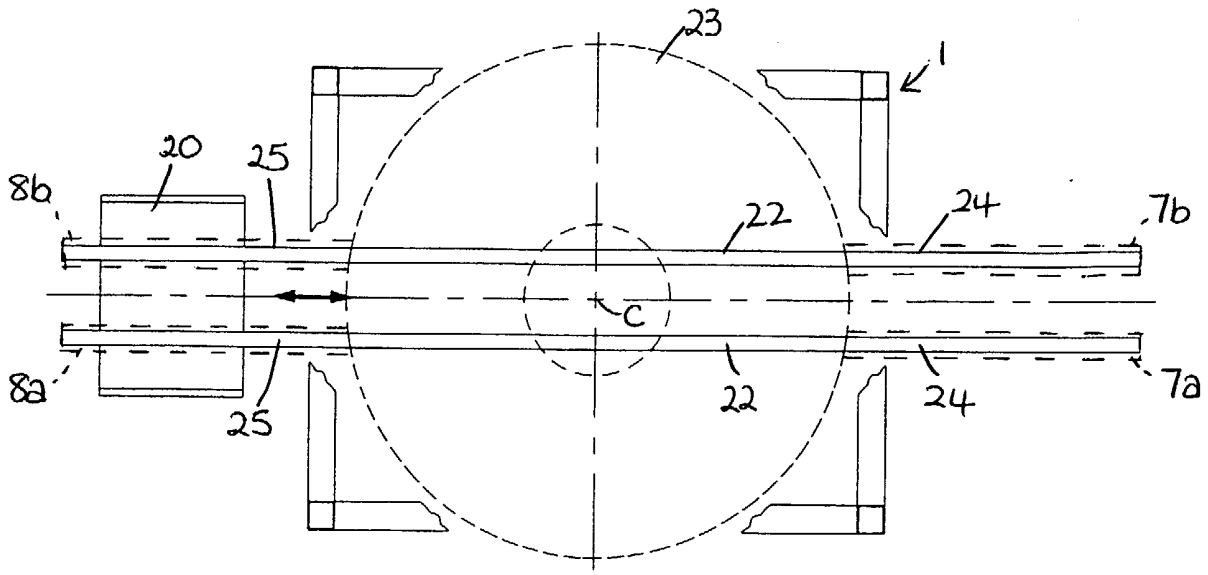

FIG. 2

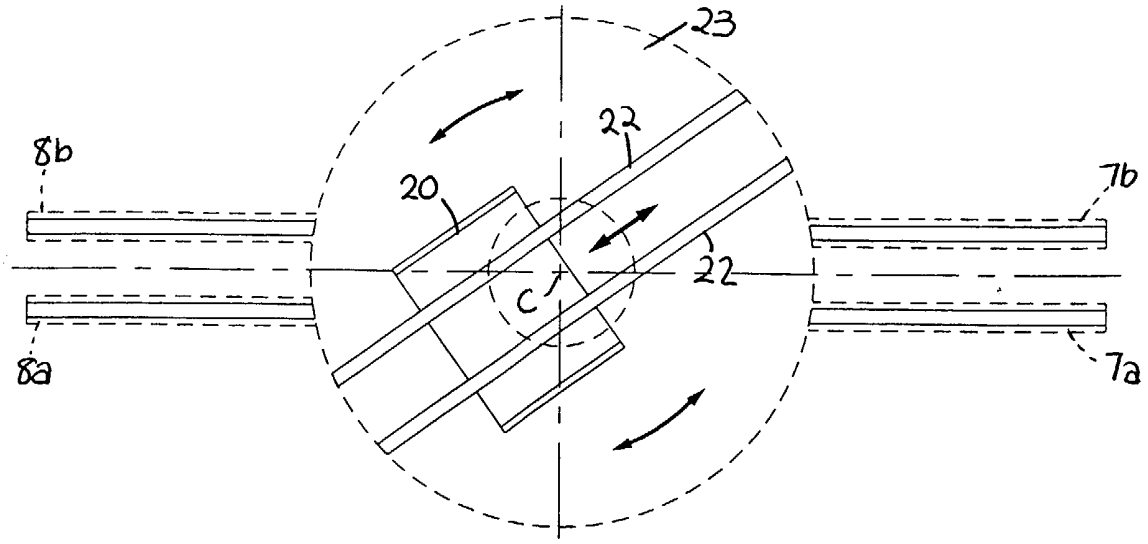

FIG. 3

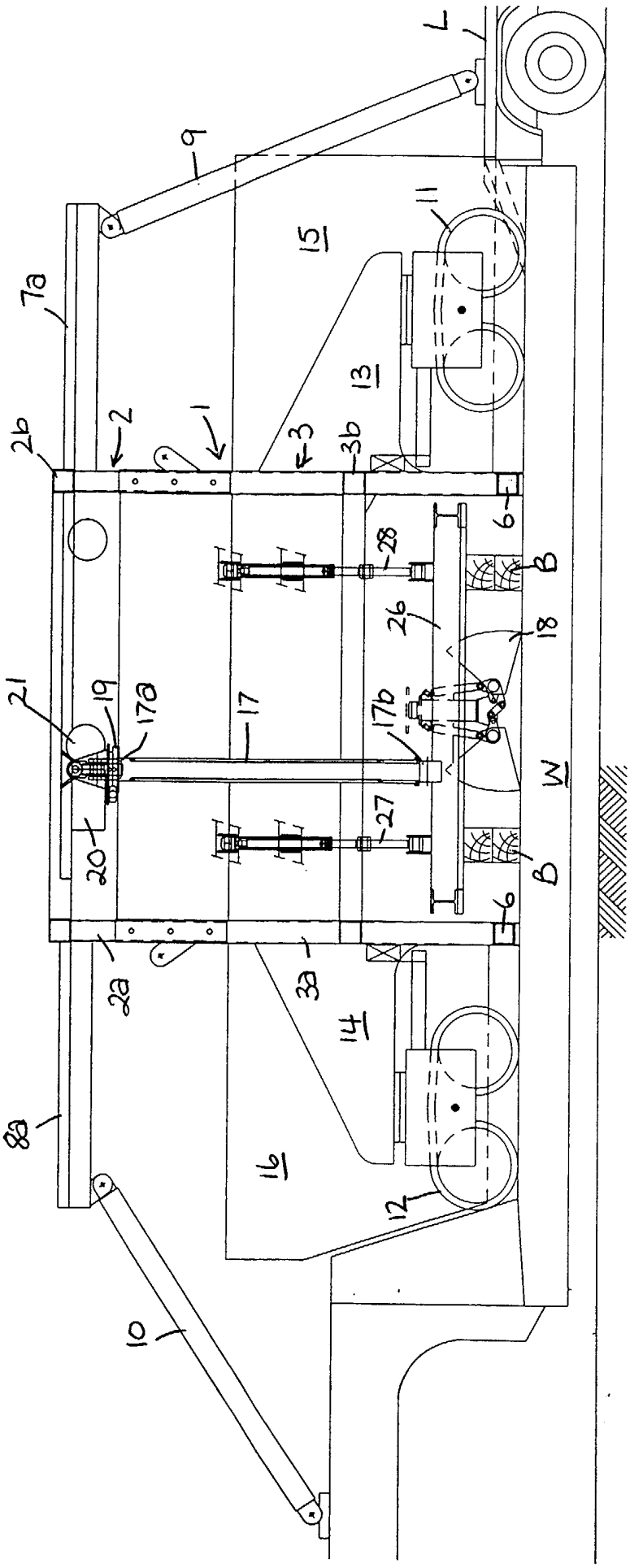
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FIG. 4

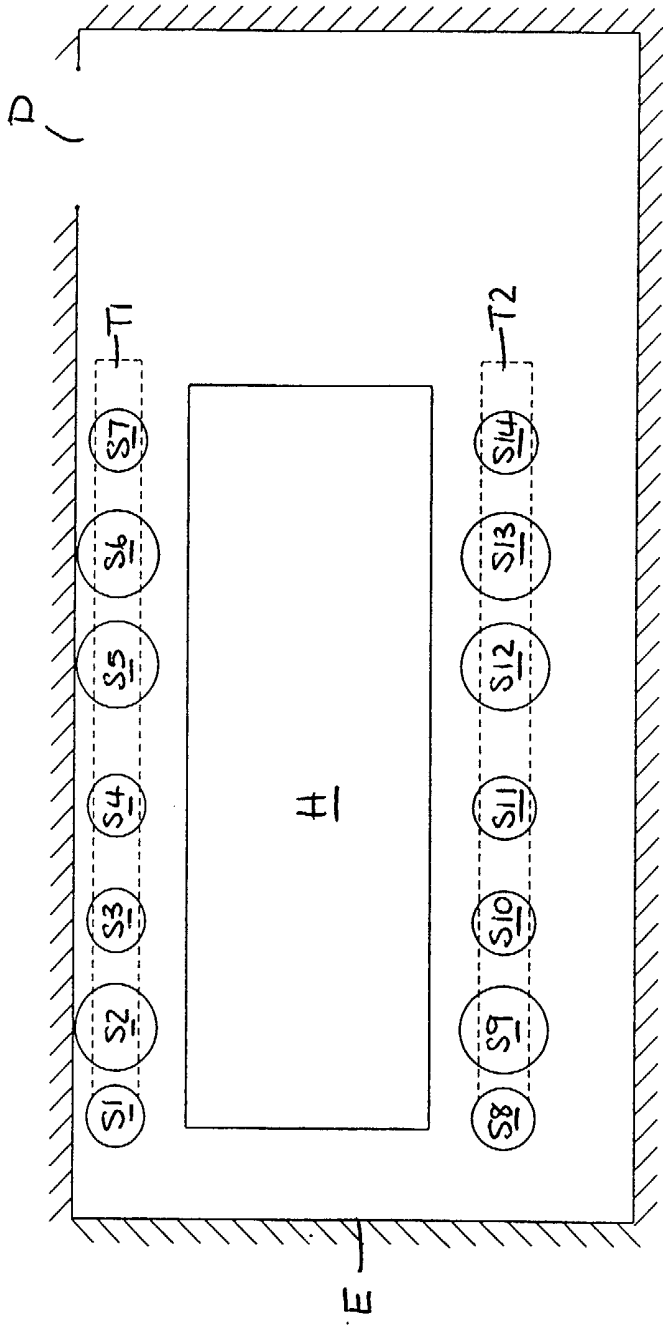

FIG. 5

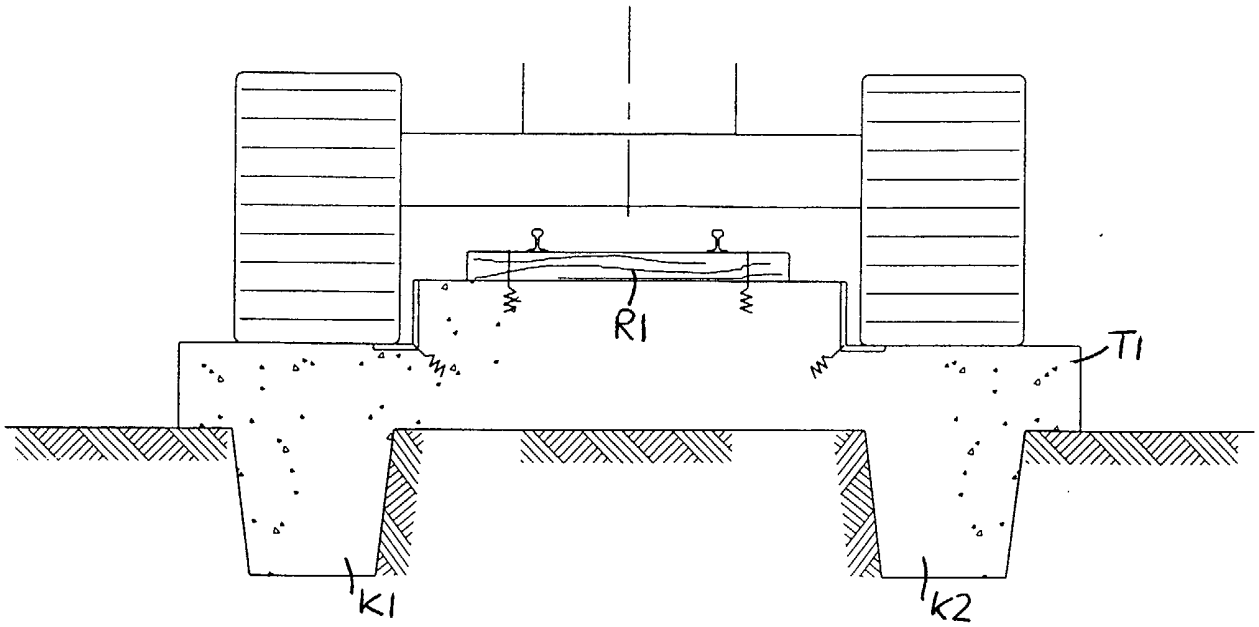

FIG. 7

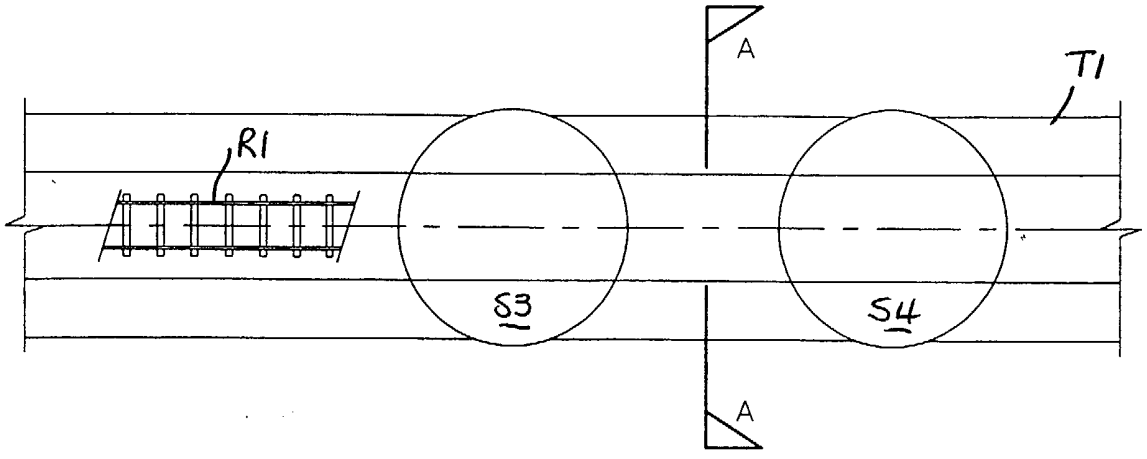

FIG. 6

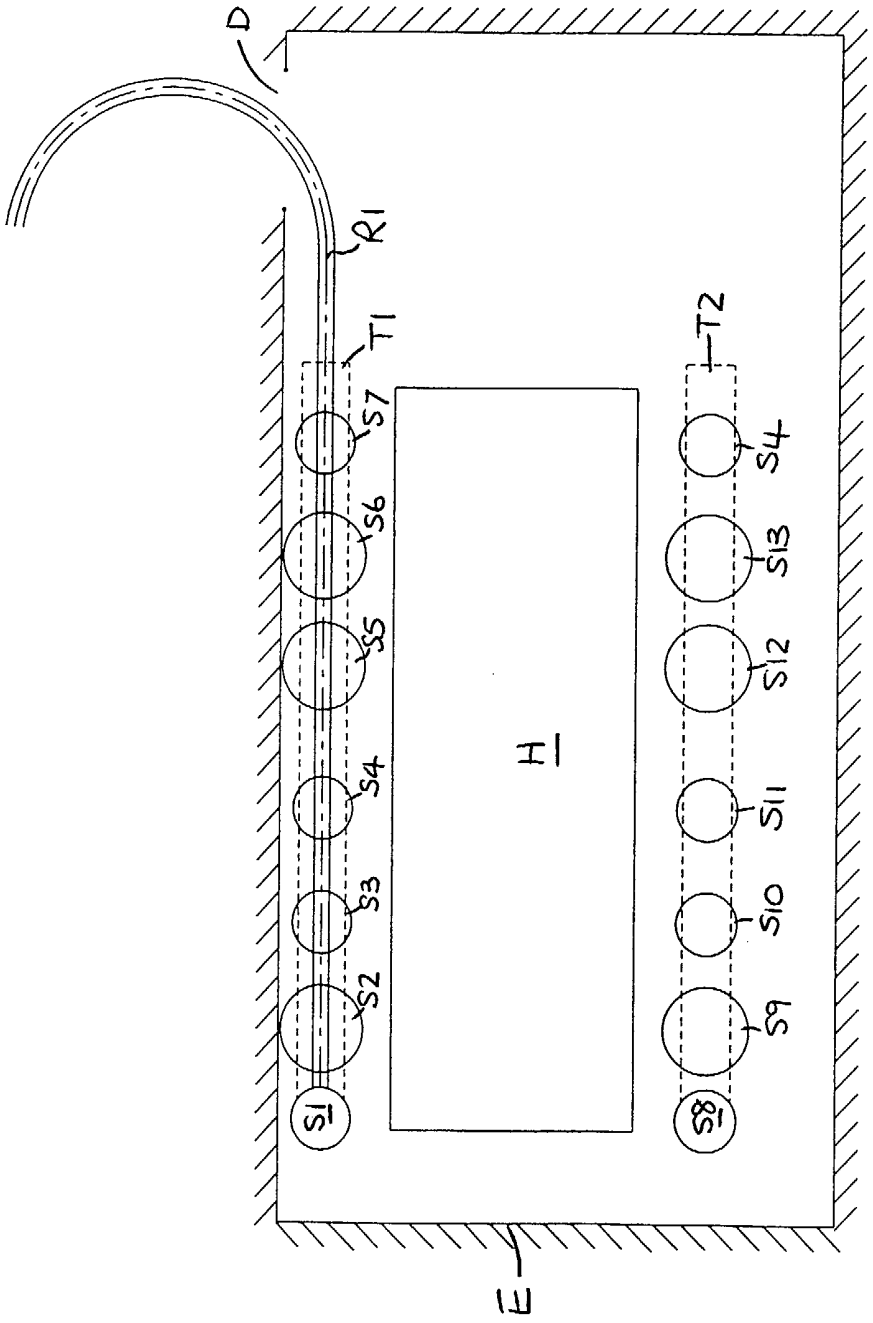

FIG. 8

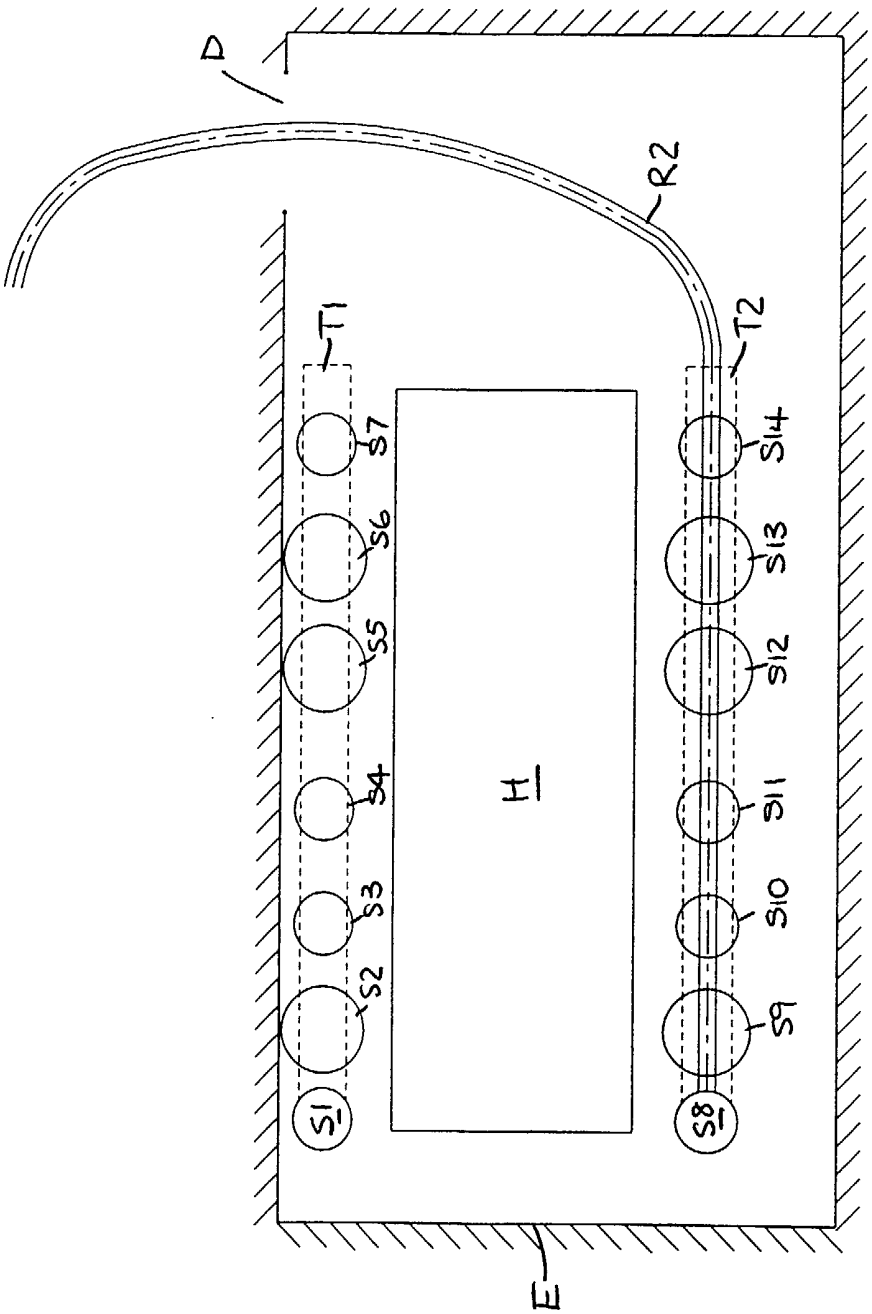

FIG. 9

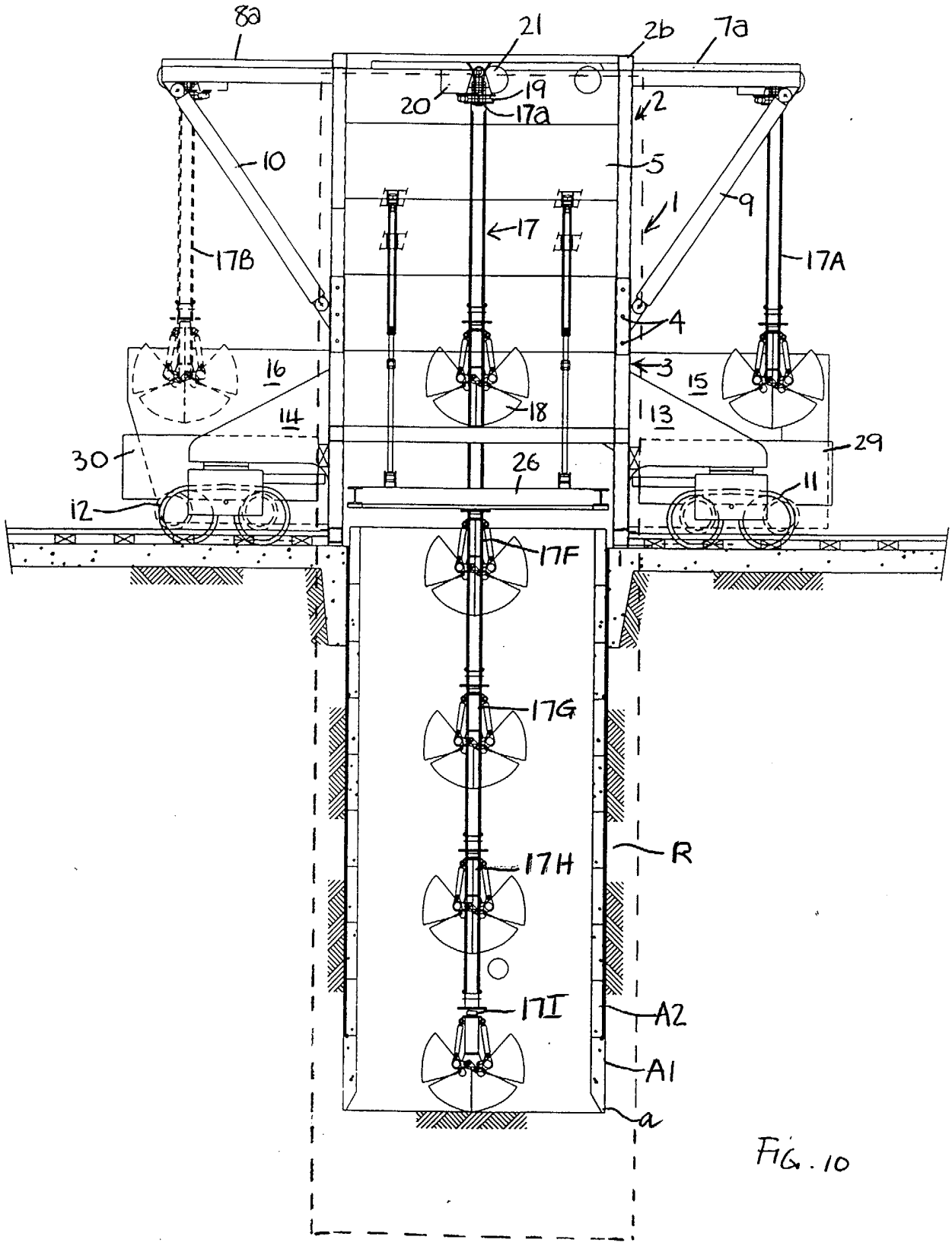
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FIG. 10

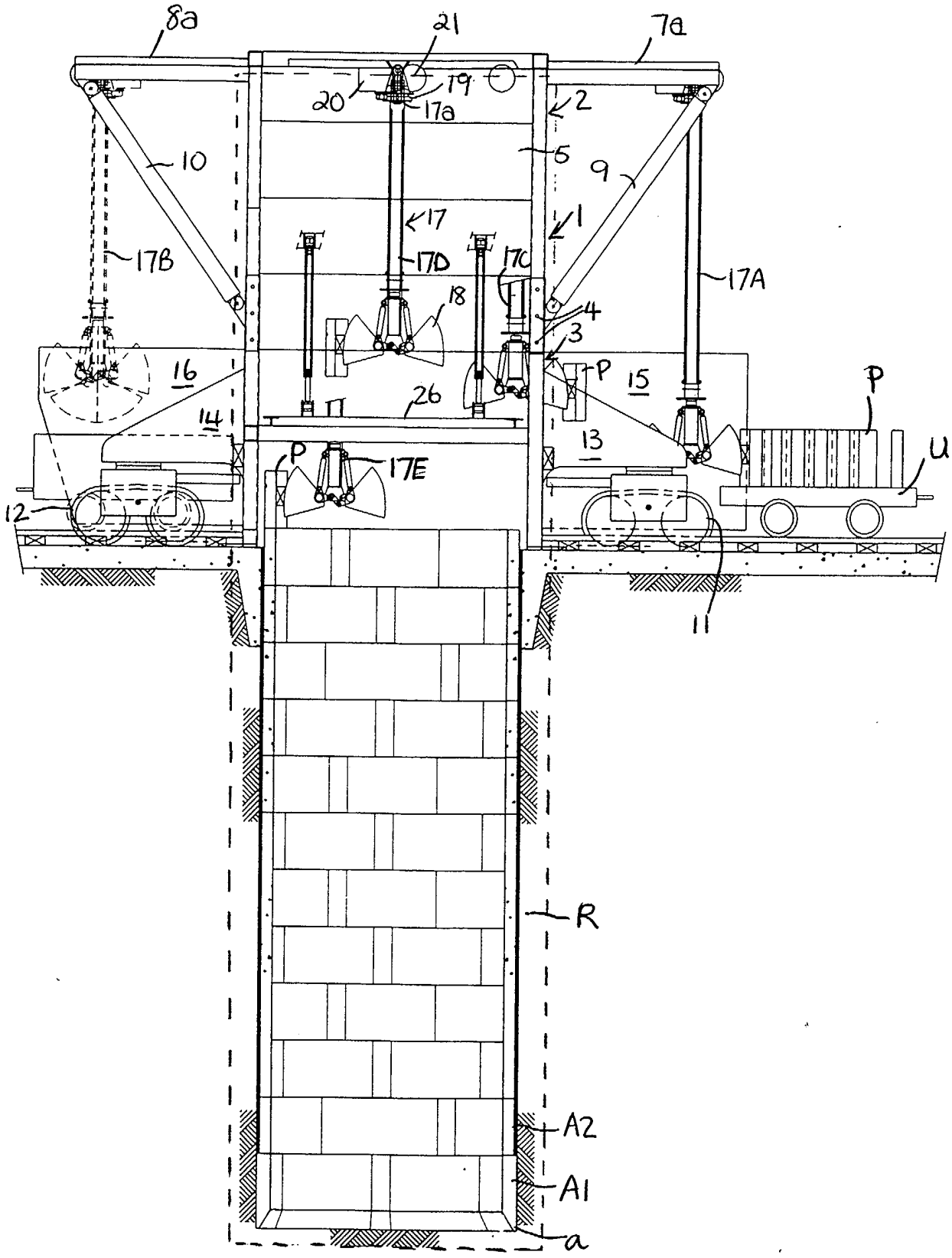
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FIG. 11

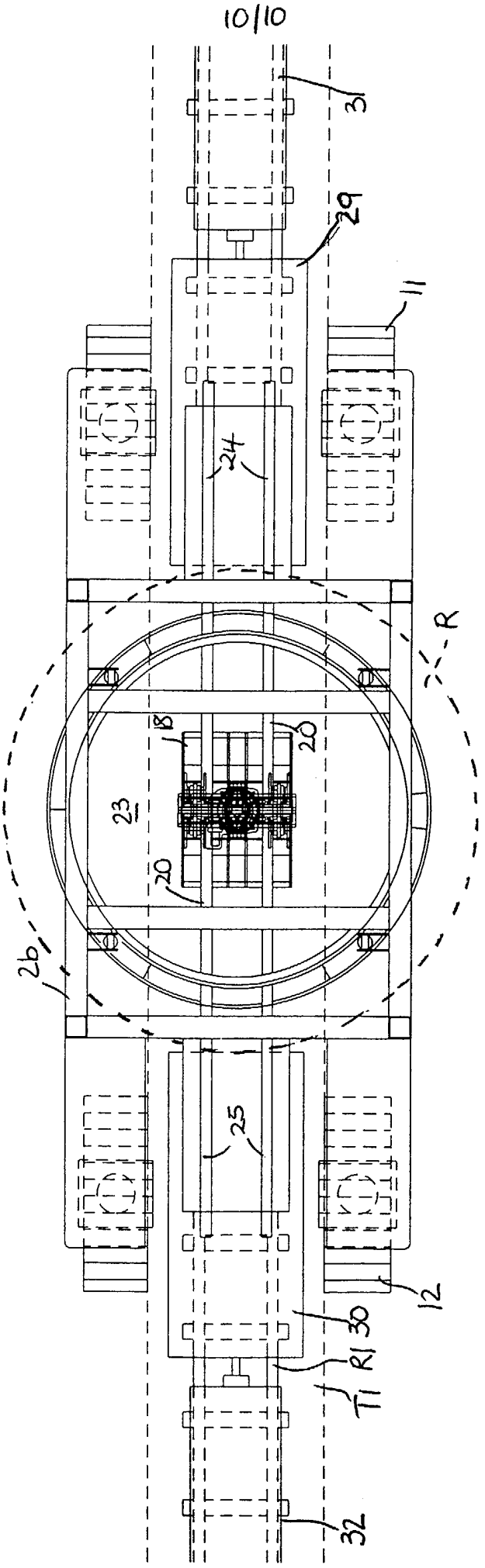

FIG. 12

"Improvements in and relating to excavation"

The invention relates to a method and apparatus for excavating the ground especially for the installation of foundations, for example, bearing piles or caissons, or for the insertion of other structures including pipes and other construction materials, and also to a method and apparatus for the installation of foundations or the insertion of other structures into the ground.

In the installation of foundations, especially relatively large diameter bearing piles, caissons or similar structures that need to extend into the ground to a considerable depth, an excavator vehicle having an hydraulically powered arm provided with a grab operated by a person within the vehicle is commonly used to carry out excavation. The arm generally comprises a goose-necked boom pivotally mounted at one end on the vehicle and a dipper, which carries the grab, pivotally mounted on the other end of the boom. During the excavation, the boom and dipper are pivoted by the operator, who also manoeuvres the vehicle, to position the grab for detaching and picking up material from the site. The boom and dipper are then swung away from the site by the operator, with the vehicle again being manoeuvred if required, so that the grab can off-load the material at a deposition point, for example, a skip. The vehicle and arm must then be repositioned by the operator for further excavation. In certain situations, foundations have to be inserted, and/or excavations carried out, in a confined space because of the presence of walls or other installations where there is insufficient space for such a vehicle and its arm to manoeuvre as required. In some cases there are walls or installations, for example, service pipes or electricity supply cables, damage to which by such a vehicle including its arm, or even any form of contact by such a vehicle, must be avoided.

In other situations, where there is risk that the ground to be excavated is contaminated in a manner hazardous to human health, all personnel involved in the excavation and/or installation process must be equipped with suitable protective clothing and even possibly with breathing apparatus rendering physical movement arduous.

The invention provides a method of excavating the ground comprising positioning over the site to be excavated a support structure, the support structure being provided with elongate excavator means which is variable in length by extension or retraction and which carries a grab or other excavation tool, the excavator means being mounted on the support structure so that it is movable relative to the support structure within an operating region above and including the said site, the excavator means being movable relative to the support structure within the operating region by rotation about a longitudinal axis passing through a mean point and by moving in a radial direction from the said mean point transverse to the said axis, the excavator means also being capable of movement from within the operating region to outside it along a predetermined path, the method further comprising extending and/or retracting the excavator means, moving the excavator means within the operating region to excavate the site and moving the excavator means along the predetermined path to deposit material excavated from the site, extension and retraction of the excavator means and movement of the excavator means within the operating region and along the predetermined path being controlled from a position outside the operating region.

The invention also provides apparatus for excavating the ground comprising a support structure for positioning over a site to be excavated, the support structure being provided with elongate excavator means which is variable in length by extension

or retraction and is arranged to carry a grab or other excavation tool, the excavator means being mounted on the support structure so that it is movable relative to the support structure within an operating region above and including the said site, the excavator means being movable relative to the support structure within the operating region by rotation about a longitudinal axis passing through a mean point and by moving in a radial direction from the said mean point transverse to the said axis, the apparatus also comprising means defining a predetermined path along which the excavator means can move from within the operating region to outside it, and means for controlling extension and retraction of the excavator means and movement of the excavator means from a position outside the operating region.

With the method and apparatus of the invention, the excavator means, which may be equipped with a grab at one end in use during excavation, but might instead be equipped with, for example, an impact hammer or a cutter tool if necessary, can be moved and/or varied in length by an operator using control means at a position outside the operating region. The control means may include umbilical connection means or radio control means. Thus, if there are hazardous conditions at the site, the operator can be located at a safe distance therefrom. The excavator means can be moved by rotation about the said longitudinal axis (which is generally substantially vertical in use and may, but need not, coincide with the central vertical axis of the support structure) and/or in a radial direction from the said mean point (generally in a direction substantially normal to the said axis in use). The capability of the excavator means to be moved in that manner and to be extended and/or retracted in length enables the grab mounted on the excavator means to be positioned at a wide range of positions and depths. Thus, the arrangement can be such that the grab can reach any point on the

site to be excavated. During the removal and/or picking up of material at the site, however, the excavator means remains within the operating region, which generally comprises a region of ground below the support structure including the site to be excavated and its immediate environs at least to a depth to which excavation is required and also comprises an above-ground region directly above the site. Excavated material can be off-loaded from the grab at one or more deposition points outside the operating region by travel by the excavator means along one or more predetermined paths. Thus, freedom of movement of the excavator means can be restricted to the operating region and the predetermined path or paths and excavation can be carried out in a confined space and in situations where there are walls or other installations that must be safeguarded from accidental damage by, or accidental contact with, the excavator means. Although it may be necessary for personnel to assist in delivering empty skips or other receptacles for receiving excavated material at the or each deposition point and for removing full ones, they need not enter the operating region itself, and such equipment can be arranged to travel along a track or other guide means that is fixed, at least while excavation is taking place.

Advantageously, the excavator means is so mounted as to be rotatable relative to the support structure about its own longitudinal axis.

The excavator means is advantageously telescopic in length so that, when required, it can be extended for deeper excavation and/or retracted. It preferably comprises a plurality of co-axial tubular members of different diameters that are movable in an axial direction relative to each other so that they can be retracted inside one another in a telescopic manner or extended to the length required.

Advantageously, the excavator means is arranged to move in the said radial

direction within the operating region about the said mean point on internal guide means. With such an arrangement, the internal guide means is advantageously mounted for rotation about the said mean point. The arrangement is preferably such that the internal guide means can be aligned with the path defining means to allow the excavator means to be moved onto, and along, the said path from the internal guide means.

Drive means, which is preferably hydraulic, for enabling movement of the excavator means relative to the support structure and/or the extension and retraction of the excavator means and/or rotation of the excavator means about its own longitudinal axis is advantageously provided, preferably mounted on, or located adjacent to, the support structure.

When a series of sites are to be excavated, for example, for the insertion of a plurality of relatively large diameter bearing piles or caissons, before the support structure is positioned over the first site, support structure guide means is advantageously installed along which the support structure can be moved and guided from one site to an adjacent site, and means is preferably provided for moving the support structure along its guide means. Thus, for example, the support structure may be provided with one or more bogeys arranged to run on its guide means which may be laid on the ground. The or each bogey, which may have tracks or wheels, is preferably steerable to allow for manoeuvring the support structure as it is moved from one site to the next. With such an arrangement, the or each bogey may carry the drive means referred to above. Such guide means for movement of the support structure may also serve as guide means, or support further guide means, for example, rail track, for the transport of skips or other receptacles to and from the site, and also for the delivery of

construction materials to the site, if required. In that manner, a series of sites can be excavated each within a confined region in a controlled manner without endangering surrounding structures, and the work necessary for personnel to carry out at the site can be reduced.

The invention also provides a method of installing foundations or inserting other structures including pipes and other construction materials into the ground comprising excavating the ground by positioning over the site to be excavated a support structure, the support structure being provided with elongate excavator means which is variable in length by extension or retraction and which carries a grab or other excavation tool, the excavator means being mounted on the support structure so that it is movable relative to the support structure within an operating region above and including the said site, the excavator means being movable relative to the support structure within the operating region by rotation about a longitudinal axis passing through a mean point and by moving in a radial direction from the said mean point transverse to the said axis, the excavator means also being capable of movement from within the operating region to outside it along a predetermined path, the method further comprising extending and/or retracting the excavator means, moving the excavator means within the operating region to excavate the site and moving the excavator means along the predetermined path to deposit material excavated from the site, extension and retraction of the excavator means and movement of the excavator means within the operating region and along the predetermined path being controlled from a position outside the operating region, and inserting the said foundations or other structures into the site.

The invention also provides apparatus for the installation of foundations or

other structures into the ground comprising a support structure for positioning over a site to be excavated, the support structure being provided with elongate excavator means which is variable in length by extension or retraction and is arranged to carry a grab or other excavation tool, the excavator means being mounted on the support structure so that it is movable relative to the support structure within an operating region above and including the said site, the excavator means being movable relative to the support structure within the operating region by rotation about a longitudinal axis passing through a mean point and by moving in a radial direction from the said mean point transverse to the said axis, the apparatus also comprising means defining a predetermined path along which the excavator means can move from within the operating region to outside it, means for controlling extension and retraction of the excavator means and movement of the excavator means from a position outside the operating region, and means for urging the said foundations or other structures into the site.

When caissons that extend a considerable distance into the ground are to be inserted, the caissons will generally be constructed from annular sections, which may themselves be contructed from segments. A shallow pit is excavated and a first annular section, which may be constructed from steel, cast iron, concrete or other proprietary material, is positioned at the site. While excavation is continued, the annular section is urged into the ground. When it has travelled a certain distance, a second annular section is positioned on top of the first annular section, and the second annular section urged into the ground, pushing the first section ahead of it, the ground being excavated from inside the annular sections to allow the insertion to take place. With the arrangement of the invention, the excavator means can be used to assist in the

construction, positioning and installation of the annular sections at the site. The means for urging the annular sections into the ground may be hydraulically operated and controlled from outside the operating region.

A method and apparatus for excavating the ground and for installing foundations or inserting other structures in accordance with the invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Fig. 1 is an elevation of the apparatus;

Fig. 2 is a diagrammatic plan of a portion of the apparatus;

Fig. 3 is a diagrammatic plan of the portion of the apparatus shown in Fig. 2 with further parts removed and in a different stage of operation;

Fig. 4 is an elevation of the apparatus in a retracted state for transport on a low loader;

Fig. 5 is a diagrammatic plan of a site for excavation and installation of two series of caissons with tracks laid;

Fig. 6 is a portion of the plan of Fig. 5 on a larger scale;

Fig. 7 is a cross-section through the track shown in Fig. 6 taken along the line A-A;

Fig. 8 is a diagrammatic plan of the site of Fig. 5 with rail track laid for the excavation and installation of the first series of caissons;

Fig. 9 is a diagrammatic plan of the site of Fig. 5 with rail track laid for the excavation and installation of the second series of caissons;

Fig. 10 is an elevation of the apparatus during excavation showing excavator means at several different locations;

Fig. 11 is an elevation of the apparatus during a further step also showing the

excavator means at several different locations; and

Fig. 12 is a plan of the apparatus on a larger scale than Figs. 10 and 11.

Referring to the accompanying drawings and initially to Fig. 1, the apparatus comprises a support structure indicated generally by the reference numeral 1 in the form of a tower constructed from upper and lower support structure sections, indicated generally by the reference numerals 2 and 3, respectively. Each support structure section 2 and 3 comprises four upright members 2a and 3a, respectively, one at each corner of the structure, and four transversely extending steel members forming frames 2b and 3b, respectively. The upright members 2a and 3a and the transverse members 2b and 3b may be made, for example, of steel. The upper support structure section 2 is positioned vertically over the lower support structure section 3 and is detachably secured to it by pins 4. On two opposing sides (only one of which is shown in Fig. 1) the structure 1 has side walls 5 of heavy duty ballast plates secured together. The other two sides of the structure 1 are open .

At the bottom of the lower support structure 3, the upright members 3a are provided with independently adjustable outriggers 6 for increasing the stability of the support structure 1. At the top of the support structure 1 on each of its open sides, two pairs of transverse beams 7a, 7b and 8a, 8b, respectively, (see also Figs. 2 and 3) are secured to the structure at one end and extend outwardly away from the structure. The beams 7a, 7b and 8a, 8b of each pair are arranged parallel to each other and spaced apart. Two pairs of supporting struts 9 and 10, respectively, (only one strut of each pair being shown) on each side of the structure 1 are each pivotally connected to the free end of one of the transverse beams 7a, 7b and 8a, 8b and detachably connected to the support structure 1.

Tracked bogeys 11 and 12, respectively, are provided on each open side of the support structure 1 and are linked thereto, each of the bogeys being steerable independently of the other. Each bogey 11 and 12 carries a casing 13 and 14, respectively, containing a diesel hydraulic power pack (not shown) and/or an electro-hydraulic power pack (not shown), either of which can be used to move the support structure 1 to and from the site as described below, and in excavation and installation of foundations as also described below. Two pairs of protective side cowls 15 and 16, respectively, only one of each pair being shown in Fig. 1, extend outwardly from the support structure 1 on each side around the bogeys 11 and 12.

Within the support structure 1 is mounted elongate excavator means, indicated generally by the reference numeral 17. The excavator means 17 is mounted at one end 17a on the support structure to hang vertically downwards, its other end 17b having a grab 18 mounted on it. The excavator means 17 is composed of several co-axial tubular portions which can be retracted inside one another in a telescopic manner, or extended to the length required. Operation of the grab 18 and extension and retraction of the excavator means 17 is effected from one of the power packs within the casings 13 and 14 and controlled from a remote position by an operator using control means (not shown) connected to the apparatus by umbilical connections (not shown) or by radio control. The grab 18 is detachable and can be exchanged for another tool, for example, an impact hammer or a cutting tool (neither of which are shown) if required.

At its end 17a, the excavator means 17 is suspended from a 360° slew ring 19, which allows the excavator means to rotate about its own longitudinal axis and which, in turn, is mounted on a trolley 20. The trolley 20 is driven by a motor 21 powered from one of the power packs in the casings 13 and 14 and controlled from a remote

position in a similar manner as that described above. The trolley 20 is arranged to run on parallel rails 22 (see Fig. 3), movement of the trolley along the rails in either direction causing the excavator means 17 to move in a radial direction in a horizontal plane relative to a mean point C located at the centre of the support structure 1. The rails 22 are mounted on a rotatable bearing 23, which can be rotated about a vertical axis passing through mean point C to allow the excavator means 17 to travel in any horizontal radial direction about the point C. Thus, the excavator means 17 with the grab 18 is movable within an operating region R as shown in broken lines in Figs. 10 and 11. The operating region R is a generally cylindrical region comprising a below-ground region including the site to be excavated to a depth exceeding (at least to a small extent) the full depth required and its immediate environs, and an above-ground region directly above the below-ground region. The diameter of at least the below-ground portion of the operating region R is the full extent of the radial movement of the excavator means 17 on the rails 22 and the reach of the grab 18 beyond the excavator means. The grab 18 cannot be raised higher than the position in which it is held by the excavator means 17 in its fully retracted state.

In one position of the rails 22, the rails align with further rails 24 and 25 extending along the transverse beams 7a, 7b and 8a, 8b, respectively, to enable the excavator means 17 to travel from within the operating region R to outside it on a predetermined path along either the beams 7a, 7b or the beams 8a, 8b on each open side of the support structure 1 as shown in Fig. 2.

The support structure 1 is also equipped with a thrust ring 26 located within the support structure and mounted on hydraulic rams 27 and 28, respectively, (only two of which are shown) for assisting in the installation of foundations in a manner

described below.

In Fig. 1 the apparatus is shown on a well W of a low loader L (only the rear of which is shown), which can be used to transport the apparatus to a construction site.

In operation, the apparatus can be moved to the construction site on the low loader L, it being moved onto the well W of the low loader by means of the bogeys 11 and 12 driven by the power packs within the casings 13 and 14. When in position on the low loader L, the support structure 1 can be put into a retracted form as shown in Fig. 4. That is achieved by first lowering the thrust ring 26 until it is supported on blocks B and detaching it from the hydraulic rams 27 and 28. The struts 9 and 10 are then disconnected from the upright members 2a and 3a and the pins 4 removed. The upper support structure section 2 is then lowered using the hydraulic rams 27 and 28 so that it is at least partially retracted into the lower section 3. In that manner, the overall height of the support structure 1 is reduced. The grab 18 is detached from the excavator means 17 as it reaches the floor of the well W. The struts 9 and 10 are secured to fixed points on the low loader L to provide stability during transport. On reaching the general area of the site, the retraction operation described above is reversed and the support structure 1 unloaded from the low loader L.

Referring now to Figs. 5 to 8, two series of caissons, the sites of which are indicted by the reference numerals S1 to S7 and S8 to S14, respectively, are to be installed in the ground on each side of a building H in confined regions between the building H and exterior walls E, the exterior walls having an entrance D. Firstly, the sites S1 to S14 for the individual caissons are blanked off and concrete tracks T1 and T2 are laid. As can be seen from Fig. 7, the concrete track T1 (the track T2 is similar) is cast with shear keys K1 and K2 extending into the ground. Rail track R1 is then laid

on the track T1 extending from the caisson site S1 across the caisson sites S2 to S7 and out through the entrance D. The support structure 1 is manoeuvred through the entrance D and along the concrete track T1 by means of the bogeys 11 and 12 and the power packs within the casings 13 and 14. After installation of the support structure 1 over the site S1, skips 29 and 30, which may be driven by locomotives 31 and 32, respectively, as shown in Fig. 12 or they may be hand-pushed or winched into position, are positioned between the bogeys 11 and 12 and within the protective side cowls 15 and 16 on each open side of the structure.

The excavator means 17 and the grab 18 are then operated from a remote position outside the operating region R using the control means via the umbilical connections or by radio control to excavate a shallow pit at the site S1, the excavator means being positioned for digging by moving the trolley 20 along the rails 22, by rotating the bearing 23 and by extending its length, if required. The excavator means 17 may also be rotated about its own longitudinal axis, if required. The capability of the excavator means to move in a radial direction along the rails 22, to rotate about a vertical axis by means of the bearing 23 and to extend or shorten its length enables the grab 18 (or other tool) to reach any position required for excavation of the site within the operating region R. While the excavator means 17 and grab 18 are digging, they stay within the operating region R and cannot come into contact with either the building H or the walls E. When it is necessary to empty the grab 18, the rails 22 are aligned with the rails 24 and 25 and the excavator means 17 is retracted in length and moved on one of the predetermined paths along the beams 7 and 8 to either the position 17A or the position 17B shown in Fig. 10 where the grab can deposit excavated material into the skip 29 or 30. Operation can be such that one of the skips

29 and 30 is filled as the other is taken away by its locomotive for emptying along the fixed track T1. Although a driver is required for the locomotive, all other functions can be operated remotely, and do not require the presence of personnel at the site. As explained above, that is especially advantageous if conditions at the site are hazardous to human health.

After the shallow pit has been excavated, a first annular ring section A1 constructed from segmental plates P secured together and having a cutting edge *a* is built *in situ*, the plates being transported to the site along the rail track R1 on under-carriage U and moved into the operating region R. To do that, the excavator means 17 can be moved along the rails 24 of the beams 7a, 7b once again to the position 17A (see Fig. 11) where the grab 18 can pick up a plate P and transport it into the operating region moving through positions 17C, 17D and 17E as shown in Fig. 11 until the plate P is in the desired location. Although the excavator means 17 has been shown picking up a plate P in the position 17 A, the plates P could equally well be brought to the other side of the support structure 1 and the excavator means moved to the position 17B. When the first annular ring section A1 is complete it is urged into the ground using the thrust ring 26 and the hydraulic rams 27 and 28 while excavation by the grab 18 within the annular ring is continued. When the first ring section A1 has been inserted by a certain distance, a second annular ring section A2 is built in a similar manner and positioned on top of the first ring section. The thrust ring 26 is then used to urge the second annular ring section A2 into the ground with the first ring section A1 ahead of it, while at the same time carrying on the excavation from within the rings. By repeating that process, a caisson comprising a series of the annular ring sections can be inserted into the ground, the excavator means 17 being extended in length through

the positions 17F to 17I as required. After installation, the hollow ring sections are filled with concrete or completed internally as required.

The support structure 1 can then be moved down the track T1 to the site S2 of the next caisson and the operation repeated. When all the caissons S1 to S7 have been inserted, the track T1 can be taken up and a new track T2 laid to the second series S8 to S14. The whole operation can then be repeated.

Claims

1. A method of excavating the ground comprising positioning over the site to be excavated a support structure, the support structure being provided with elongate excavator means which is variable in length by extension or retraction and which carries a grab or other excavation tool, the excavator means being mounted on the support structure so that it is movable relative to the support structure within an operating region above and including the said site, the excavator means being movable relative to the support structure within the operating region by rotation about a longitudinal axis passing through a mean point and by moving in a radial direction from the said mean point transverse to the said axis, the excavator means also being capable of movement from within the operating region to outside it along a predetermined path, the method further comprising extending and/or retracting the excavator means, moving the excavator means within the operating region to excavate the site and moving the excavator means along the predetermined path to deposit material excavated from the site, extension and retraction of the excavator means and movement of the excavator means within the operating region and along the predetermined path being controlled from a position outside the operating region.

2. A method as claimed in claim 1, wherein the movement of the excavator means within the operating region and along the predetermined path is controlled using umbilical connection means or radio control means.

3. A method as claimed in claim 1 or claim 2, wherein the excavator means is rotatable relative to the support structure about its own longitudinal axis.

4. A method as claimed in any one of claims 1 to 3, wherein the excavator means is telescopic in length.

5. A method as claimed in claim 4, wherein the excavator means comprises a plurality of co-axial tubular members of different diameters that are movable in an axial direction relative to each other so that they can be retracted inside one another or extended.

6. A method as claimed in any one of claims 1 to 5, wherein the movement of the excavator means and/or the extension and retraction of the excavator means and/or the rotation of the excavator means about its own longitudinal axis is driven hydraulically.

7. A method as claimed in any one of claims 1 to 6 for excavating a plurality of sites wherein, before the support structure is positioned over the first site, support structure guide means is installed, and the support structure is moved from one site to an adjacent site along its guide means.

8. A method as claimed in claim 7, wherein the support structure is provided with steerable moving means to allow for manoeuvring the support structure as it is moved from one site to the next.

9. A method as claimed in claim 7 or claim 8, wherein the support structure guide means serves as guide means, or supports further guide means, for the transport of skips or other receptacles to and from the site.

10. A method of installing foundations or inserting other structures including pipes and other construction materials into the ground comprising excavating the ground by positioning over the site to be excavated a support structure, the

support structure being provided with elongate excavator means which is variable in length by extension or retraction and which carries a grab or other excavation tool, the excavator means being mounted on the support structure so that it is movable relative to the support structure within an operating region above and including the said site, the excavator means being movable relative to the support structure within the operating region by rotation about a longitudinal axis passing through a mean point and by moving in a radial direction from the said mean point transverse to the said axis, the excavator means also being capable of movement from within the operating region to outside it along a predetermined path, the method further comprising extending and/or retracting the excavator means, moving the excavator means within the operating region to excavate the site and moving the excavator means along the predetermined path to deposit material excavated from the site, extension and retraction of the excavator means and movement of the excavator means within the operating region and along the predetermined path being controlled from a position outside the operating region, and inserting the said foundations or other structures into the site.

11. A method as claimed in claim 10, wherein the foundations comprise a plurality of annular sections, and the method comprises urging the annular sections into the ground and excavating from inside the sections.

12. A method of excavating the ground and a method of installing foundations substantially as hereinbefore described with reference to the accompanying drawings.

13. Apparatus for excavating the ground comprising a support structure for

positioning over a site to be excavated, the support structure being provided with elongate excavator means which is variable in length by extension or retraction and is arranged to carry a grab or other excavation tool, the excavator means being mounted on the support structure so that it is movable relative to the support structure within an operating region above and including the said site, the excavator means being movable relative to the support structure within the operating region by rotation about a longitudinal axis passing through a mean point and by moving in a radial direction from the said mean point transverse to the said axis, the apparatus also comprising means defining a predetermined path along which the excavator means can move from within the operating region to outside it, and means for controlling extension and retraction of the excavator means and movement of the excavator means from a position outside the operating region.

14. Apparatus as claimed in claim 13, wherein the excavator means has a grab or other excavation tool attached to its said one end.

15. Apparatus as claimed in claim 13 or claim 14, wherein the control means comprises umbilical connection means or radio control means.

16. Apparatus as claimed in any one of claims 13 to 15, wherein the excavator means is so mounted as to be rotatable relative to the support structure about its own longitudinal axis.

17. Apparatus as claimed in any one of claims 13 to 16, wherein the excavator means is telescopic in length so that it can be extended or retracted.

18. Apparatus as claimed in claim 17, wherein the excavator means comprises a plurality of co-axial tubular members of different diameters that are movable in

an axial direction relative to each other so that they can be retracted inside one another or extended.

19. Apparatus as claimed in any one of claims 13 to 18, wherein there is provided internal guide means within the operating region on which the excavator means is arranged to move in a radial direction about the said mean point.

20. Apparatus as claimed in claim 19, wherein the internal guide means is mounted for rotation about the said mean point.

21. Apparatus as claimed in claim in claim 19 or claim 20, wherein the arrangement is such that the internal guide means can be aligned with the path defining means to allow the excavator means to be moved onto, and along, the said path.

22. Apparatus as claimed in any one of claims 13 to 21, wherein drive means for enabling movement of the excavator means relative to the support structure and/or the extension and retraction of the excavator means and/or rotation of the excavator means about is own longitudinal axis is provided.

23. Apparatus as claimed in claim 22, wherein the drive means is hydraulic drive means.

24. Apparatus as claimed in any one of claims 13 to 23, which comprises means for enabling movement of the support structure along support structure guide means.

25. Apparatus as claimed in claim 24, wherein the moving means comprises one or more steerable bogeys.

26. Apparatus for the installation of foundations or other structures into the ground comprising a support structure for positioning over a site to be excavated, the

support structure being provided with elongate excavator means which is variable in length by extension or retraction and is arranged to carry a grab or other excavation tool, the excavator means being mounted on the support structure so that it is movable relative to the support structure within an operating region above and including the said site, the excavator means being movable relative to the support structure within the operating region by rotation about a longitudinal axis passing through a mean point and by moving in a radial direction from the said mean point transverse to the said axis, the apparatus also comprising means defining a predetermined path along which the excavator means can move from within the operating region to outside it, means for controlling extension and retraction of the excavator means and movement of the excavator means from a position outside the operating region, and means for urging the said foundations or other structures into the site.

27. Apparatus as claimed in claim 26, wherein the means for urging the said foundations into the ground is hydraulically operated and controlled from outside the said region.

28. Apparatus for excavating the ground and apparatus for the installation of foundations substantially as hereinbefore described with reference to, and as shown in, the accompanying drawings.

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Application No: GB 0109928.2
Claims searched: All

Examiner: Philip Osman
Date of search: 15 August 2001

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.S): E1F (FWB), (FWC), (FWE), (FWM)

Int Cl (Ed.7): E02D, E02F, E21B

Other: Online: WPI, EPODOC, PAJ

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
A	GB 235,268	(Birtwhistle, Overstall) Figs. 2 & 3	
A	JP 8,319,618	(Mitsui Eng & Shipbuilding Co) Figs.	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
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