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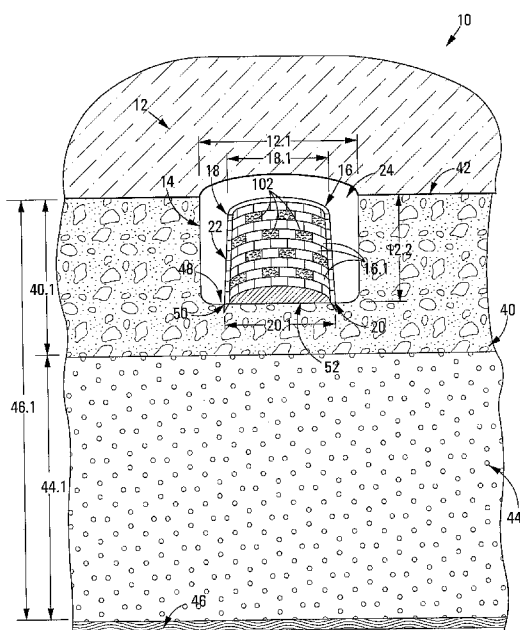


FIG 1

- (57) Abstract:** The invention relates to a method of constructing a well. The method includes excavating an initial well hole of a depth which is a fraction of the final depth of the well, providing a first frusto-conical well wall segment in the initial well hole, excavating the well hole deeper from inside of the first well wall segment, thereby allowing the first well wall segment to sink deeper, and stacking additional frusto-conical well wall segments on top of each other as the well hole is deepened. The method is continued until the first frusto-conical well wall segment is at a desired depth and the frusto-conical well wall extends to ground level. The method extends also to a well constructed in accordance with the invention, the well including a frusto-conical well wall comprising a stacked arrangement of frusto-conical well wall segments.

A WELL AND A METHOD OF CONSTRUCTING A WELL

5 THIS INVENTION relates to the extraction of groundwater. More particularly, the invention relates to a method of constructing a well and to a well constructed in accordance with such a method.

Wells are commonly used in the extraction of groundwater from waterlogged sand. In
0 the context of this specification waterlogged sand refers to sand that is saturated with groundwater. Waterlogged sand is usually found below a certain level in the ground, referred to as the water table. The depth of the water table varies and depends on the area in which the well is constructed. Water-logged sand may typically be found
beneath the water table up to a depth where an impermeable layer of clay or sand is
15 found, beyond which water does not pass. Wells are typically constructed by providing a channel from beneath the water table to the ground surface within which groundwater can accumulate and subsequently be extracted to the surface. The channel is usually in the form of a shaft, sunken into the ground, or simply a hole made in the ground which is lined with sand impermeable material so as to prevent
20 sand caving back into the well. In this regard there may be distinguished between two types of wells, namely driven point (sand point) wells and tubular wells.

Driven point wells are small diameter wells made by driving a drive-point well screen, which has a sharp leading end and is connected to lengths of pipe, into the ground to below the water table. The purpose of the screen is to allow water to filter into the driven point well and to keep out the surrounding sand. Water which has accumulated
5 inside the well can subsequently be pumped to the surface through the pipe(s) connected to the screen. A problem associated with the operation of these types of wells is that sand may enter the well and may clog up perforations and/or pipes or damage the pumping system.

0 Tubular wells are wells which have a substantially larger diameter than driven-point wells and are constructed either by sinking a tubular column into the ground to a desired depth below the water table, or by digging a hole to the desired depth below the water table and lining the hole with a sand impermeable well lining, thereby
5 allowing a volume of water to flow into the column from the bottom of the well due to the surrounding pressures of the water table. Water can subsequently be pumped from the volume of water which accumulates in the well to the surface by providing a flow channel from the water volume to the surface. A problem associated with the installation of these types of wells is that whilst sinking the well, well hang-up may occur, wherein the sinking of the well is hindered due to friction and grip of the sand
20 on the outside of the well lining preventing the wall from sinking downwards.

The applicant believes that the invention will alleviate at least some of the difficulties associated with the operation and installation of the well types as described above,

especially in loose ground formations without a binder which may cave in before a lining is installed. Further, due to the diameter of the wall being smaller than the diameter of the leading edge, friction is reduced sufficiently to allow the well lining to slide downwards when material is removed from inside, next to, and below the leading edge.

According to a first aspect of the invention, there is provided a method of constructing a well, the method including the steps of:

- selecting a location for constructing a well;
- 0 excavating material at the selected location to form an initial well hole of a depth which is a fraction of the final depth of the well;
- providing a first frusto-conical well wall segment in the initial well hole to form a height of frusto-conical well wall, the well wall segment having a bottom end of larger outer diameter than an upper end thereof and the well wall segment and the well hole
- 5 being relatively sized so that a peripheral space is defined in the initial well hole around the well wall segment;
- excavating material from the inside of the first well wall segment to deepen the well hole, allowing the first well wall segment to sink deeper as the well hole is deepened;
- 20 providing a further frusto-conical well wall segment on top of the previous one to extend the height of frusto-conical well wall;

excavating more material from the inside of the first well wall segment to further deepen the well hole, allowing the height of frusto-conical well wall to sink deeper as the well hole is deepened; and

5 similarly further deepening the well hole and providing at least one more frusto-conical well wall segment on top of the previous ones until the first frusto-conical well wall segment is at a desired depth and the frusto-conical well wall extends to ground level.

Selecting an area in which to construct the well may involve taking into account
0 factors which may include any of:

the depth of the water table below ground level;

the depth below an upper level of the water table at which an impermeable layer of clay or sand is found which prevents water to pass beyond it;

the depth of water saturated sand; and

15 the coarseness of the water-saturated sand.

The depth of water saturated sand may be determined by calculating the difference between the depth of the water table and the depth of an impermeable layer underneath. The respective depths of the water table and impermeable layer may be
20 determined using a metal rod as hereinafter described. Preferably the depth of the water saturated sand may be between about 2 and 4 meters. More preferably the depth of the water saturated sand may be about 4 meters.

The method may include displacing at least some of the excavated material to the peripheral space to at least partially fill the space.

5 The initial well hole may be substantially round cylindrical. The peripheral space defined in the initial well hole around the first well wall segment may be between 0.65m and 0.95m, for accommodating workers constructing the well. The height of the first well wall segment may be between 75% and 125% of the diameter of the initial well hole.

0 The depth of the initial well hole may typically be such that the bottom of the hole is at a desired distance from the water table. The distance between the bottom of the initial well hole and the water table may be selected such that the sand at the bottom of the initial well hole is damp with water, but not fully waterlogged, thereby providing a firm surface for constructing the first well wall segment. The depth may also be selected to
15 facilitate determining the depth of the impermeable layers and the depth to which water may be found. Preferably, the bottom of the initial well hole is at a level between 100mm and 200mm above a water table.

20 The method may include, after excavating the initial well hole, determining the depth of a water table and a water impermeable layer underneath by probing into the bottom of the initial well hole with a long rod and taking measurements on the rod.

The method may include reinforcing the well wall by placing external reinforcement around the well wall segments. The reinforcement may include at least one of steel wire and steel wire netting. The reinforcement may include a layer of rendering material. The rendering material may have a 4:1 sand:cement mix. The peripheral
5 space defined in the initial well hole around the first well wall segment may assist in applying the reinforcement to the well wall by allowing access to the outer side of the well wall. The reinforcement may thus be applied incrementally, particularly to each well wall segment whilst it is positioned in the initial well hole.

0 It is envisaged that at some stage during excavation of the well hole, the water table will be reached, at which stage water will seep into the well. In such a case, the method may include pumping out water seeping into the well hole so as to facilitate further excavation. It is expected that the pumping rate should be faster than the required yield of the well.

5

The further excavation of the hole may be ceased at any desired depth. Preferably excavation may be ceased when the depth of the water flowing into the well inhibits effective excavation of the hole. More preferably excavation may be ceased when the depth of the water flowing into the well is 1 meter from the bottom of the hole whilst
20 water is being pumped from the hole. In any event excavation should be ceased about 0.5 meters before the impermeable layer is reached.

The frusto-conical well wall segments may be manually constructed in situ from construction elements. The construction elements may be bricks or other building blocks secured together by means of mortar.

5 Alternatively, the frusto-conical well wall segments may be pre-fabricated units. The pre-fabricated units may be configured to interconnect and/or interlock, thereby to define the frusto-conical well wall. The pre-fabricated units may be made of any suitable material, for example concrete, steel plate, plastic, or fiberglass.

0 Yet alternatively, the frusto-conical well wall segments may be units, each unit comprising a pre-fabricated mould and a fill material introduced into the mould after placement of the mould in the well hole. The mould may be made of fiberglass. The fill material may be a settable cementitious material. It is envisaged that the mould will be filled with fill material after each well wall segment has been placed in position.

5

A bottom edge of the first well wall segment may be chisel-shaped in cross-section, thereby defining a cutting edge. The cutting edge may be on the outer diameter of the bottom end of the first well wall segment.

20 The method may include extending the well wall up to a level above ground level by providing at least one more well wall segment on top of the previous ones. The level above ground level may be between 0.4m and 1.0m above ground level. The level above ground level may be determined by the typical depth of water which may

envelop the well during floods. Extending the well wall to a level above such a depth may therefore prevent floodwater from entering the well.

5 The well wall may be at least partially constructed of water permeable concrete thereby to permit passage of water through the wall. So, for example, in the case of the well wall segments being constructed in situ from construction elements, as referred to above, at least some of the elements may be water permeable. Such building elements may be cast with a no-fines concrete. More particularly, the building elements may be cast with a 5 to 1 mixture of a 10 to 18 mm aggregate, the mixture
0 being dampened before compaction. Such building elements will have a porous structure. If the wall is partially constructed of such building elements, these building elements may be interspersed between other, non-porous building elements. In such a case rendering will, at least, not be applied on the outside surface of the porous building elements.

15

According to a second aspect of the invention, there is provided a well constructed in accordance with a method in accordance with the first aspect of the invention.

According to a third aspect of the invention, there is provided a well including a frusto-
20 conical well wall comprising a vertically stacked arrangement of frusto-conical well wall segments.

Further features of the well of the third aspect of the invention may be analogous to features of the well constructed in accordance with the method of the first aspect of the invention, as described above.

- 5 The invention will now be described by way of example only, with reference to the following diagrammatic drawings.

In the drawings:

- Figure 1 shows a longitudinal section of a well hole having a first well wall
0 segment provided therein;

Figure 2 shows a longitudinal section of the well hole of Figure 1, the hole having been further excavated and a second well wall segment having been added to the first well wall segment;

- Figure 3 shows a longitudinal section of a complete frusto-conical well wall
15 which has been constructed in accordance with the invention;

Figure 4 shows suitable sites for constructing a frusto-conical well in a sandy river terrain;

Figure 5 shows suitable sites for constructing a frusto-conical well in wetlands or an area having permanently waterlogged ground;

- 20 Figure 6 shows the construction of a frusto-conical well in a swamp area;

Figure 7 shows a three dimensional view of a vertical section of a frusto-conical well wall segment;

Figure 8 shows a long section of a first well wall segment of a well in accordance with the invention;

Figure 9 shows a long section of an alternative well wall segment of a well in accordance with the invention; and

5 Figure 10 shows a long section of another alternative well wall segment of a well wall in accordance with the invention.

Referring in particular to Figure 1, reference numeral 10 generally indicates an area which has been selected as suitable for the construction of a well, the area 10 having
0 a water table 40 a depth 40.1 below the ground surface 42. Waterlogged sand 44 is found to a depth 44.1 beneath the level of the water table 40 and an impermeable layer 46 of clay (or sand) is found at a depth 46.1 from the surface 42. The area has an initial well hole 12 excavated therein, the hole 12 having a sidewall 14, a diameter 12.1 and a depth 12.2 from the ground surface 42. In the embodiment shown in Figure
5 1 the hole 12 has been excavated to a depth 12.2 so that the bottom 48 of the hole 12 is 150mm from the level of the water table 40. A frusto-conical first well wall segment 16, having an open top 18 and bottom 20, has been constructed in the bottom 48 of the hole 12, the first well wall segment 16 having been constructed of a plurality of building elements 16.1. A number of the building elements 16.1 may be porous
20 building elements 102 manufactured of a no-fines concrete. The bottom 20 of the first well wall segment has an outer diameter 20.1, the diameter 20.1 of the bottom of the first well wall segment 16 being smaller than the diameter 12.1 of the hole 12, thus defining a peripheral space 24 between the sidewall 14 of the hole 12 and a peripheral

outer surface 22 of the first well wall segment 16. A bottom edge 50 of the first well wall segment 16 is chisel-shaped so as to facilitate the sinking of the first well wall segment 16 as the hole 12 is deepened.

5 Referring now to Figure 2, reference numeral 10 generally indicates the same area as represented in Figure 1. The hole 12 has been further excavated to a depth 12.3 below the surface 42 by excavating material 30 from the bottom 52 of the hole 12 on the inside of the first well wall segment 16, the first well wall segment 16 now having been sunk past the water table 40 and into the waterlogged sand 44. A second well
0 wall segment 30 has been constructed from building elements 26.1 on top of the first well wall segment 16. Excavated material 26 has been displaced to the space 24 between the sidewall 14 of the hole 12 and the peripheral outer surface 22 of the first well wall segment 16, the space 24 having been further defined by a peripheral outer surface 54 of the second well wall segment 26.

5

In accordance with the method of the invention the process of further excavating the inside of the well wall, displacing excavated material 26 to the space 24 and constructing further well wall segments on top of an existing well wall segment, or combination of well wall segments, is continued until the well is at a desired depth and
20 the well wall extends to the ground surface 42.

Referring now to Figure 3, reference numeral 60 generally indicates a completed frusto-conical well which has been constructed in accordance with the method of the

invention. The well 60 is in the area 10 as represented in Figures 1 and 2. Further well wall segments 62 have been added to the combination of the first and second well wall segments 16, 26. The frusto-conical well 60 thus comprises a stacked arrangement of frusto-conical well wall segments 16, 26, 62, all of which have been constructed from building elements 62.1. The frusto-conical well 60 has an open top 64 and bottom 66 thereby to allow water to enter at the bottom 66 of the well 60 and be withdrawn from the top 64 of the well 60. The well wall segment further comprises a number of porous building elements 102, shown in this embodiment only in the first well wall segment. In the represented embodiment the well 60 has been sunk to a depth where the bottom 66 of the well 60 is within 0.5 meters of the impermeable layer 46.

Referring now to Figure 4, reference numeral 400 generally indicates suitable sites for constructing a frusto-conical well in a sandy river terrain 402. The terrain 402 has attributes typically associated with a sandy river, including an impermeable layer 404, a dry season water table 406, a flood season flood level 408, waterlogged sand or gravel 410 and river banks 412 of alluvial soil. During dry seasons an irrigation frusto-conical well 414 is typically constructed in the bed 416 of the river 402 by the method of the invention, a bottom of the irrigation well 414 extending past the dry season water table 406, into the waterlogged sand 410. The irrigation well 410 may provide irrigation water to surrounding agricultural applications.

A domestic frusto-conical well 418 may be constructed on the banks 412 of the sandy river to provide water for domestic purposes during dry and wet seasons. The domestic well 418 also extends past the dry season water table 406, into the waterlogged sand 410. The domestic well 416 further extends to a sufficient level
5 above ground level and above the typical flood level 408, so that during floods, when the water level of the river rises to the flood level 408, water will be prevented from entering the well 416. Although not shown in this representation, the domestic frusto-conical well 418 may also include a watertight cover which prevents water and other material from entering the well 418 during floods.

0

Referring now to Figure 5, reference numeral 500 generally indicates first and second frusto-conical wells 512, 514 which have been constructed in wetlands or an area having permanently waterlogged ground. The area has attributes typically associated with wetlands or areas having permanently waterlogged ground, including a water
5 table 502 which is located relatively shallow beneath the ground surface and results in the ground beneath the water table 502 being permanently waterlogged. The area further includes a layer of alluvial soil 504, a layer of alluvial sand and/or silt and/or gravel 506 below the layer of alluvial soil 504, an impermeable layer of rock or clay 508 and a replenishment water flow 510 beneath the surface.

20

The first and second frusto-conical wells 512, 514 represent possible locations at which frusto-conical wells may be constructed. For an area having a similar profile to the area represented in Figure 1, in that the area includes an inclined section 516, the

first frusto-conical well 512 represents the outermost position where a frusto-conical well may be installed. This is due to the fact that, should the first frusto-conical well 512 be constructed higher up against the inclined section 516, the replenishment water flow 510 will flow past the first frusto-conical well 512 and the yield of the first
5 frusto-conical well 512 will be less than optimal. The most preferable position for constructing a frusto-conical well in a wetlands area is a position selected in a section of the area having a generally flat profile. Such a preferable position is exemplified by the second frusto-conical well 514.

0 Referring now to Figure 6, reference numeral 600 generally indicates construction of a frusto-conical well in a swamp area. A first well wall segment 602 is positioned on a mud layer 604 of the area, thereby enclosing a volume of swamp water 606. The first well wall segment 602 is typically positioned on the mud layer 604 by a crane 608 which is provided on a boat 610. Alternatively, the crane 608 may also be provided on
5 a bank of the swamp area. After the first well wall segment 602 has been positioned on the mud layer 604 water enclosed therein is pumped out and excavating is commenced inside the first well wall segment 602 by the method of the invention, thereby to sink the first well wall segment 602 into the mud layer 604. A frusto-conical well is then constructed in accordance with the method of the invention so that water
20 may be withdrawn from a waterlogged sand layer 612 located beneath the mud layer 604.

Referring now to Figure 7, reference numeral 700 generally indicates a three dimensional view of a vertical section of a well wall segment of a frusto-conical well. The well wall segment 700 is constructed of building elements 702 and has an inner surface 704 and an outer surface 706. A layer of 14 to 16 gauge reinforcing steel netting wire 708 is applied to the outer surface 706 of the well wall segment. Further securing well wall segments of steel wire 710 are applied over the reinforcing steel netting wire 708 to keep it in place. It is important to note that the securing well wall segments of steel wire 710 are not applied on joints 712 where the building elements are joined, but are positioned between these joints. A 15 to 20mm thick layer of mortar plaster 712 is applied over the reinforcing steel netting wire 708 layer and the securing well wall segments of steel wire 710. In the represented embodiment plaster has only been applied to a portion of the outer surface 706 of the well wall segment 700. When complete, plaster will have been applied to the full outer surface 706, covering substantially all of the netting wire 708 and securing wire 710, except for a slim portion of netting wire 714 at a top end of the well wall segment 700 which will be left bare and over which plaster will not be applied. When a subsequent well wall segment is constructed on top of the represented well wall segment 700, netting wire which is applied to an outer surface of the subsequent well wall segment will be secured to the un-plastered portion 714 of the netting wire on the previous well wall segment 700, thus defining a continuous layer of netting along an outer surface of the well wall. When plastering is applied to the outer surface of the subsequent well wall segment, the un-plastered portion 714 of the previous section will be covered with plaster.

Referring now to Figure 8, reference numeral 800 generally indicates a first well wall segment in accordance with the invention. A layer of reinforcing plaster 802 has been applied to an outer surface of the well wall segment 800. In accordance with the invention, a lower edge 804 of the well wall segment is chisel-shaped, having a straight outer side and a slanted inner side. The chisel-shape of the edge 804 facilitates the sinking of the well wall segment into the ground, and also facilitates the excavation of material from below the edge 804, as excavation tools and implements may be inserted into the ground at an angle along the edge 804. In this embodiment the angle at which the edge 804 is slanted is 45°. A number of porous building elements 806 have further been included in the well wall segment 800. The porous building elements 806 are manufactured with a no-fines concrete comprising a 5 to 1 mixture of a 10 to 18 mm aggregate, the mixture being dampened before compaction. In the represented embodiment porous building elements are dispersed in the well wall segment 800 such that every second building element of every second row of building elements is a porous building element 806.

In Figure 9, an alternative frusto-conical well wall segment of a well in accordance with the invention is designated by the reference numeral 900. The well wall segment 900 is a pre-fabricated or pre-cast concrete unit. It has a top peripheral interconnection or interlock formation in the form of a peripheral rim 902 for engaging a complementary formation of a matching well wall segment (not show) to be placed on top of the well wall segment 900. It has a similar bottom peripheral rim 904 which can engage a

complementary formation of a matching well wall segment (not show) below the well wall segment 900.

Alternative well wall segments (not shown) may be pre-fabricated units of another
5 suitable material, for example steel, plastics, or fiberglass.

In Figure 10, another alternative frusto-conical well wall segment of a well in
accordance with the invention is designated by the reference numeral 910. The well
wall segment 910 comprises a mould 912 and fill material in the form of concrete 914
0 filled into the mould after placement of the mould in a well hole. The mould may be of
any suitable material, for example fiberglass or plastics. The mould has engagement
formations 902 and 904 similar to those of the well wall segment 900 of Figure 9, as
described above.

15 One advantage of the invention lies therein that the frusto-conical shape of the well
wall enables the well wall to sink by itself as material is excavated from the bottom of
the hole, inside the well wall, in which the well wall, or a portion or well wall segment of
the well wall, has been provided. The chisel-shape of the bottom edge of the first well
wall segment, and thus the bottom edge of the well wall, further assists in facilitating
20 the sinking of the well wall. The Applicant expects that the frusto-conical shape of the
well wall will provide an advantage over a cylindrical well wall in respect of the process
of sinking the well. Typically, direct pressure from surrounding soil on an outer surface
of the cylindrical well wall, in most cases, causes the well wall to stop sinking into the

ground, or 'hang-up', at some stage during construction, even when ground is excavated beneath the cylindrical well wall. In contrast with this, the frusto-conical shape of the wall of the well of the invention allows that the wall moves away from direct pressure from surrounding soil as the well is sunk into the ground, due to the fact that the diameter of the well wall decreases from bottom to top, resulting in compacted material around the wall becoming more loose and consequently promoting sinking of the well wall into the ground when ground is excavated from beneath the well wall on the inside thereof.

The frusto-conical shape of the well further typically has a larger storage capacity to effect than a cylindrical well. Thus, for a tubular well and a frusto-conical well constructed to equal depth beneath a ground surface, the frusto-conical well will typically have a larger volume than the tubular well and will also have a higher inflow of water at the bottom of the well. In a comparison of a tubular well having a 2 meter diameter and a 3.14m^3 volume with a frusto-conical well having a 1.5 meter upper diameter and a 3 meter lower diameter and a 14.13m^3 volume constructed in a particular area, it followed that the expected yield of water provided by the tubular well is approximately 3000 liters per hour, whilst the expected yield provided by the frusto-conical well is approximately 14 000 liters per hour. Accordingly the operating efficiency of the frusto-conical well is approximately 4 times higher than the operating efficiency of the tubular well.

A further advantage of the invention is that, by excavating inside a section having a completed well wall and displacing excavated material to the space between the inner peripheral surface defined around the hole and the peripheral outer edge of the well wall or well wall segment, and progressively adding/constructing further well wall segments whilst the hole is deepened, the danger of the sidewall of the well hole caving in on diggers, excavating the hole, is decreased as the diggers are continually protected by the existing portion of the well wall.

Another advantage of the invention is that, as the diameter of a lower end of the well is larger than the diameter of a top end of the well, water will seep into the well very slowly at the bottom and will rise faster as the diameter of the well decreases from bottom to top. Consequently, due to the specific gravity of sand being higher than the specific gravity of water and due to the initial slow rising speed of the water, most of the sand in the water seeping in at the bottom of the well will precipitate at a base of the well and will not be carried upwards with the water. Thus, it is expected that water rising into the well will contain virtually no sand. By positioning a water extraction pipe inside the well such that its inlet opening is at the highest possible water level at which water may be continuously withdrawn, it is therefore possible to extract virtually sand-free water from the well.

20

Yet another advantage of the invention is that the water in the well is, at least with regard to macro-contaminants, kept relatively safe for human consumption as the well

cover prevents contaminated floodwater, as well as other contaminants which may enter the well (such as insects), from entering the well.

Yet another advantage of the invention is that it may be effectively employed in
5 swamp areas. In such areas waterlogged sand containing groundwater which may be safe for human consumption may be found beneath a mud-layer which prevents contaminated swamp-water from infiltrating into the sand layer below the mud layer. An initial well wall element, in accordance with the invention, may be erected on the mud-layer of the swamp, thereby closing a small volume of swamp-water off from a
0 main volume of swamp water. The small volume of swamp water may subsequently be removed from within the initial well wall segment, for example by pumping, and the well may be sunk past the mud-layer into the waterlogged sand layer in accordance with the method of the invention as hereinbefore described. In this way water rising into the well will be protected from being contaminated by swamp water. In this
5 embodiment, it is envisaged that the initial well wall segment may be a prefabricated well wall segment which may be positioned in the swamp, for example by use of a crane. The crane may be on a bank of the swamp, or may be on a boat which sails into the swamp to position the initial well wall segment in a desired and/or suitable position.

20

Further advantages of the invention include that it can be constructed by semi-skilled workers and that no specialist skills are required. Further, in most cases, no expensive or complex tools or machinery are required to construct the well. The Applicant

accordingly envisages that the invention will find particular application in especially third world countries where skills are limited and maintenance and repair services or skills are not always readily available. Further, in especially third world countries expensive pumping equipment, or the skills of maintaining or repairing pumping
5 equipment is not always available. The Applicant envisages that, by the invention, clean, potable water may be drawn from the well by means of a non-automated method, such as by a bucket.

The Applicant further envisages that the well of the invention may aid in providing
0 pure, potable groundwater in areas where existing wells provide contaminated water. In this regard the Applicant expects that the use of water from wells of the invention will reduce the number of incidents of disease in undeveloped countries where waterborne diseases are prevalent.

5 The Applicant also envisages that the well of the invention will be a suitable substitute for a borehole in areas where saltwater or brackish water is found at deeper levels.

CLAIMS

1. A method of constructing a well, the method including the steps of::

selecting a location for constructing a well;

5 excavating material at the selected location to form an initial well hole of a depth which is a fraction of the final depth of the well;

providing a first frusto-conical well wall segment in the initial well hole to form a height of frusto-conical well wall, the well wall segment having a bottom end of larger outer diameter than an upper end thereof and the well wall segment and the well hole
0 being relatively sized so that a peripheral space is defined in the initial well hole around the well wall segment;

excavating material from the inside of the first well wall segment to deepen the well hole, allowing the first well wall segment to sink deeper as the well hole is deepened;

5 providing a further frusto-conical well wall segment on top of the previous one to extend the height of frusto-conical well wall;

excavating more material from the inside of the first well wall segment to further deepen the well hole, allowing the height of frusto-conical well wall to sink deeper as the well hole is deepened; and

10 similarly further deepening the well hole and providing at least one more frusto-conical well wall segment on top of the previous ones until the first frusto-conical well wall segment is at a desired depth and the frusto-conical well wall extends to ground level.

2. A method as claimed in claim 1, which includes displacing at least some of the excavated material to the peripheral space to at least partially fill the space.
- 5 3. A method as claimed in any of the preceding claims, in which the initial well hole is substantially round cylindrical.
4. A method as claimed in claim 3, in which the peripheral space defined in the initial well hole around the first well wall segment is between 0.65m and 0.95m.
- 0 5. A method as claimed in any of claims 3 to 4, in which the height of the first well wall segment is between 75% and 125% of the diameter of the initial well hole.
6. A method as claimed in any of the preceding claims, in which the bottom of the
5 initial well hole is at a level between 100mm and 200mm above a water table.
7. A method as claimed in any of the preceding claims, which includes, after excavating the initial well hole, determining the depth of a water table and a water impermeable layer underneath by probing into the bottom of the initial well hole with a
10 long rod and taking measurements on the rod.
8. A method as claimed in any of the preceding claims, which includes reinforcing the well wall by placing external reinforcement around the well wall segments.

9. A method as claimed in claim 8, in which the reinforcement includes at least one of steel wire and steel wire netting.

5 10. A method as claimed in any one of claims 8 to 9, in which the reinforcement includes a rendering layer applied around the outside of the well wall.

11. A method as claimed in any of claims 8 to 10, in which the reinforcement is applied incrementally, particularly to each well wall segment whilst it is positioned in
0 the initial well hole.

12. A method as claimed in any of the preceding claims, which includes pumping out water seeping into the well hole so as to facilitate further excavation.

15 13. A method as claimed in any of the preceding claims, in which the frusto-conical well wall segments are manually constructed in situ from construction elements.

14. A method as claimed in claim 13, in which the construction elements are bricks or other building blocks secured together by means of mortar.

20

15. A method as claimed in any one of claims 1 to 12, in which the frusto-conical well wall segments are pre-fabricated units.

16. A method as claimed in claim 15, in which the pre-fabricated units are configured to interconnect and/or interlock, thereby to define the frusto-conical well wall.

5 17. A method as claimed in any one of claims 15 to 16, in which the pre-fabricated units are made of concrete.

18. A method as claimed in any one of claims 1 to 12, in which the frusto-conical well wall segments are units, each unit comprising a pre-fabricated mould and a fill
0 material introduced into the mould after placement of the mould in the well hole.

19. A method as claimed in claim 18, in which the fill material is a settable cementitious material.

5 20. A method as claimed in any of the preceding claims, in which a bottom edge of the first well wall segment is chisel-shaped in cross-section, thereby defining a cutting edge.

21. A method as claimed in claim 20, in which the cutting edge is on the outer
20 diameter of the bottom end of the first well wall segment.

22. A method as claimed in any of the preceding claims, which includes extending the well wall up to a level above ground level by providing at least one more well wall segment on top of the previous ones.

5 23. A method as claimed in claim 22, in which the level above ground level is between 0.4m and 1.0m above ground level.

24. A method as claimed in any of the preceding claims, in which the well wall is at least partially constructed of water permeable concrete thereby to permit passage of
0 water through the wall.

25. A well constructed in accordance with a method as claimed in any of the preceding claims.

15 26. A well including a frusto-conical well wall comprising a vertically stacked arrangement of frusto-conical well wall segments.

27. A well as claimed in claim 26, which includes external reinforcement around the well wall segments.

20

28. A well as claimed in claim 27, in which the reinforcement includes at least one of steel wire and steel wire netting.

29. A well as claimed in any one of claims 26 to 28, in which the reinforcement includes a layer of cementitious material applied to the outside of the well wall.

30. A well as claimed in any of claims 26 to 29, in which the frusto-conical well wall segments are manually constructed in situ from construction elements.

31. A well as claimed in claim 30, in which the construction elements are bricks or other building blocks secured together by means of mortar.

32. A well as claimed in any one of claims 26 to 29, in which the frusto-conical well wall segments are pre-fabricated units.

33. A well as claimed in claim 32, in which the pre-fabricated units are configured to interconnect and/or interlock, thereby to define the frusto-conical well wall.

34. A well as claimed in any one of claims 32 to 33, in which the pre-fabricated units are made of concrete.

35. A well as claimed in any one of claims 26 to 29, in which the frusto-conical well wall segments are units, each unit comprising a pre-fabricated mould and a fill material introduced into the mould after placement of the mould in the well hole.

36. A well as claimed in claim 35, in which the fill material is a settable cementitious material.

37. A well as claimed in any of claims 26 to 36, in which the bottom of the initial
5 well hole is at a level between 100mm and 200mm above a water table.

38. A well as claimed in any of claims 26 to 37, in which a bottom edge of the
bottom well wall segment is chisel-shaped in cross-section, thereby defining a cutting
edge.

0

39. A well as claimed in claim 38, in which the cutting edge is on an outer diameter
of a bottom end of a bottom-most well wall segment.

40. A well as claimed in any of claims 26 to 39, in which the well wall is at least
5 partially constructed of water permeable concrete thereby to permit passage of water
through the wall.

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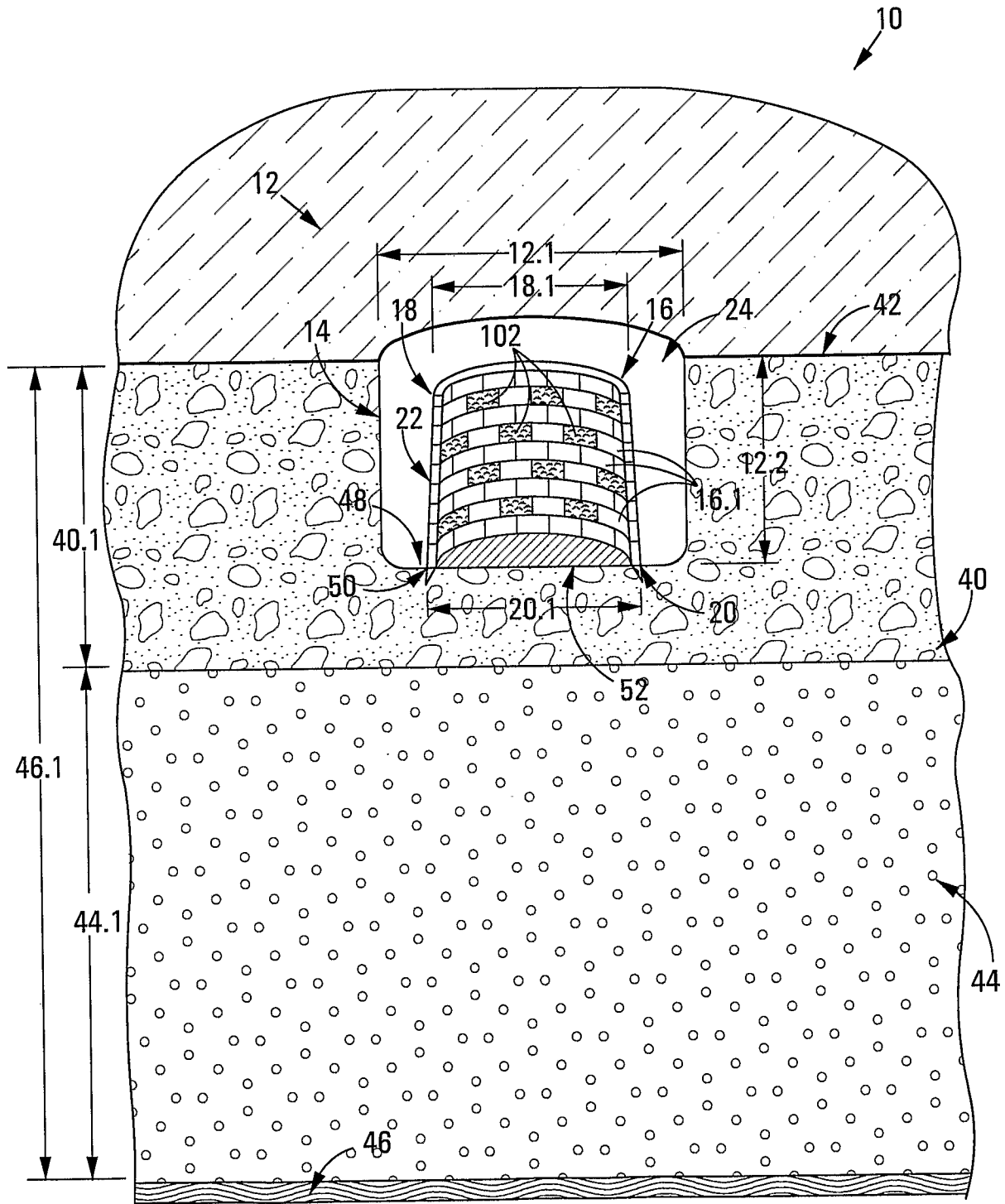


FIG 1

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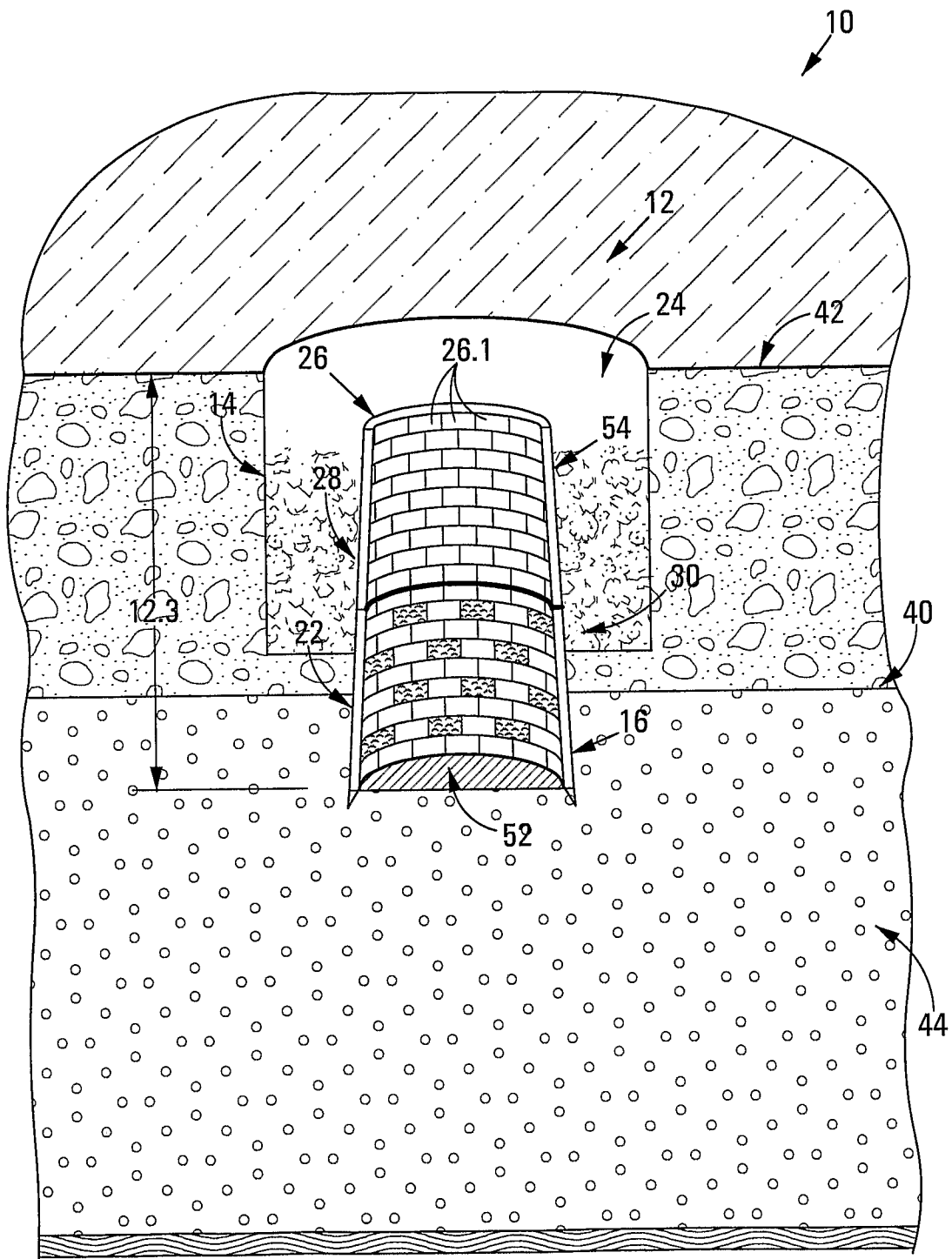


FIG 2

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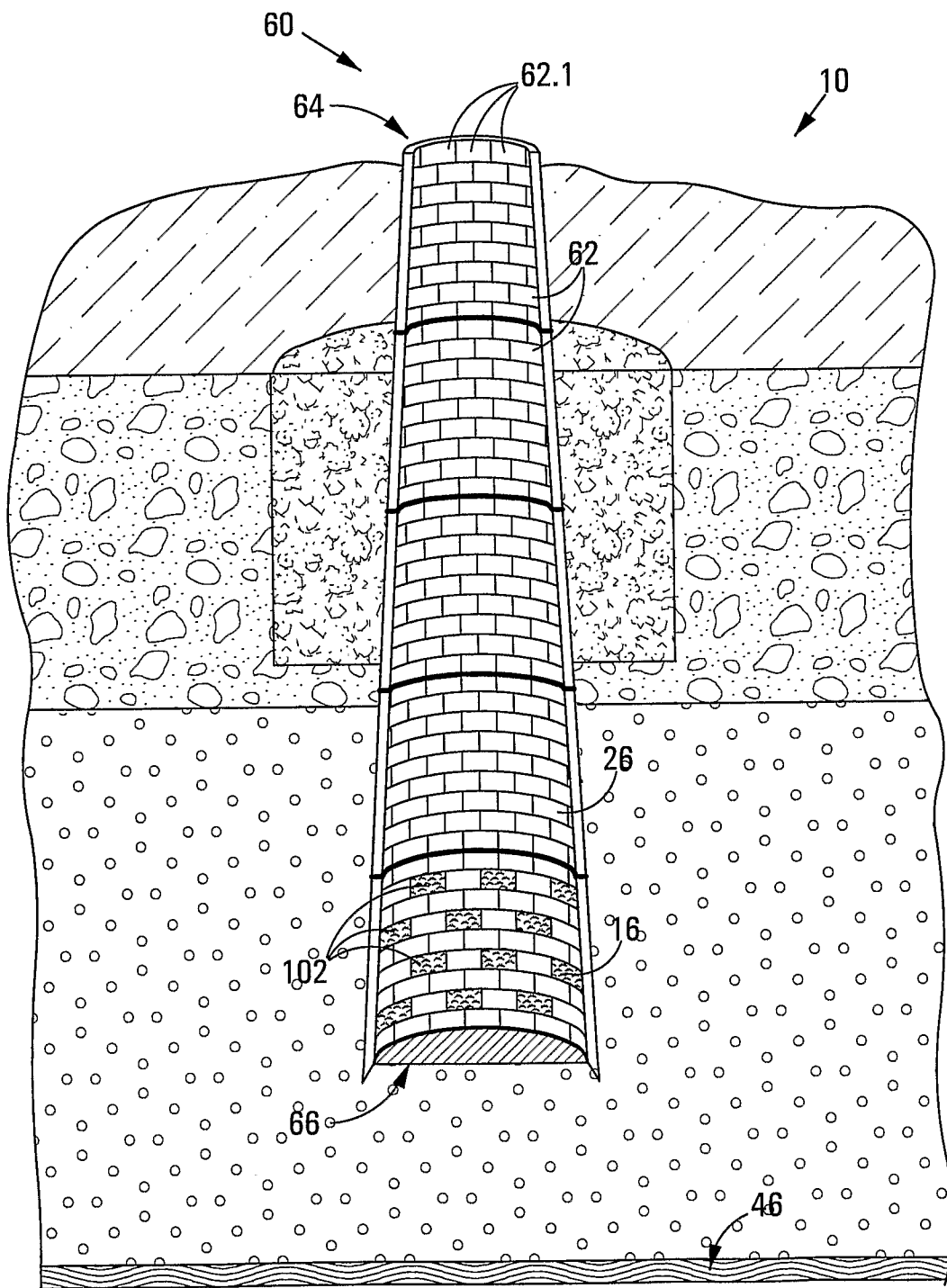


FIG 3

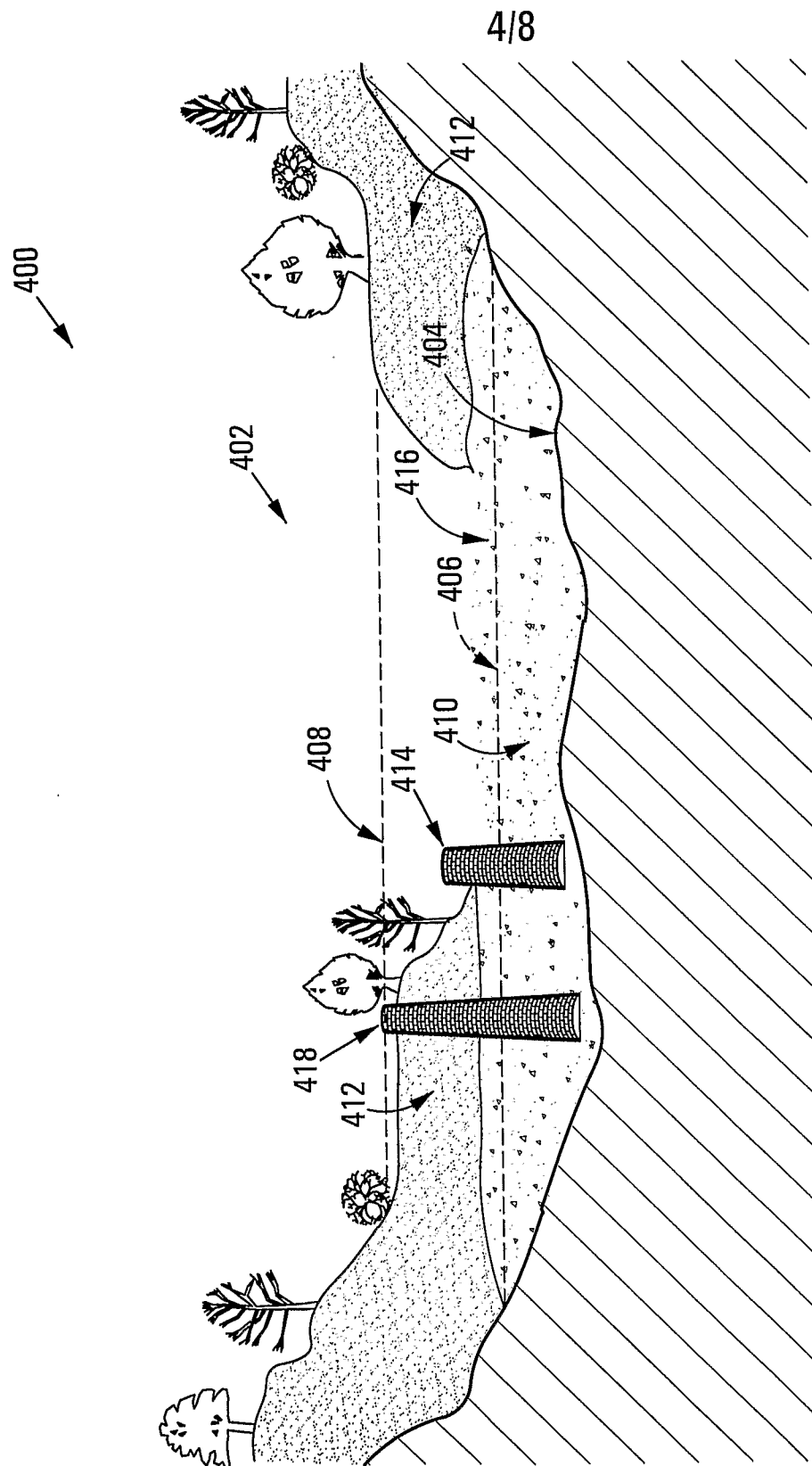


FIG 4

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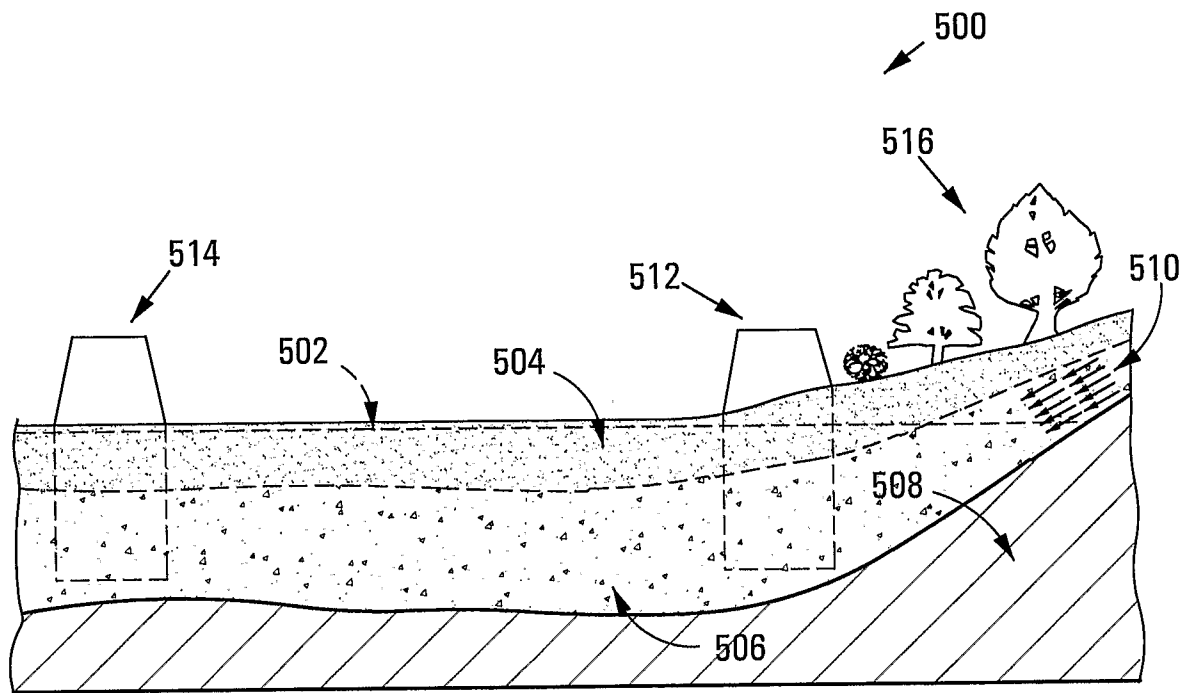


FIG 5

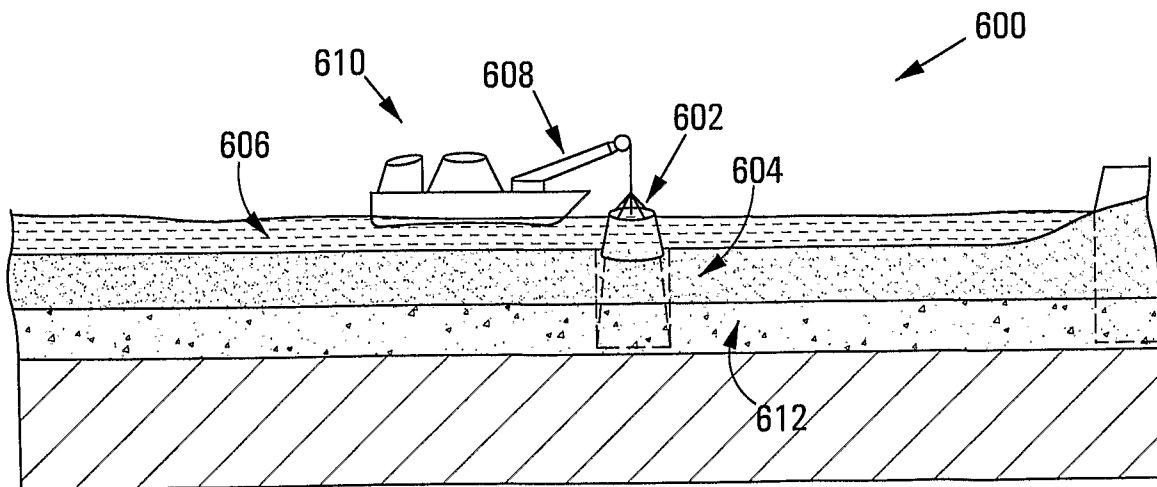
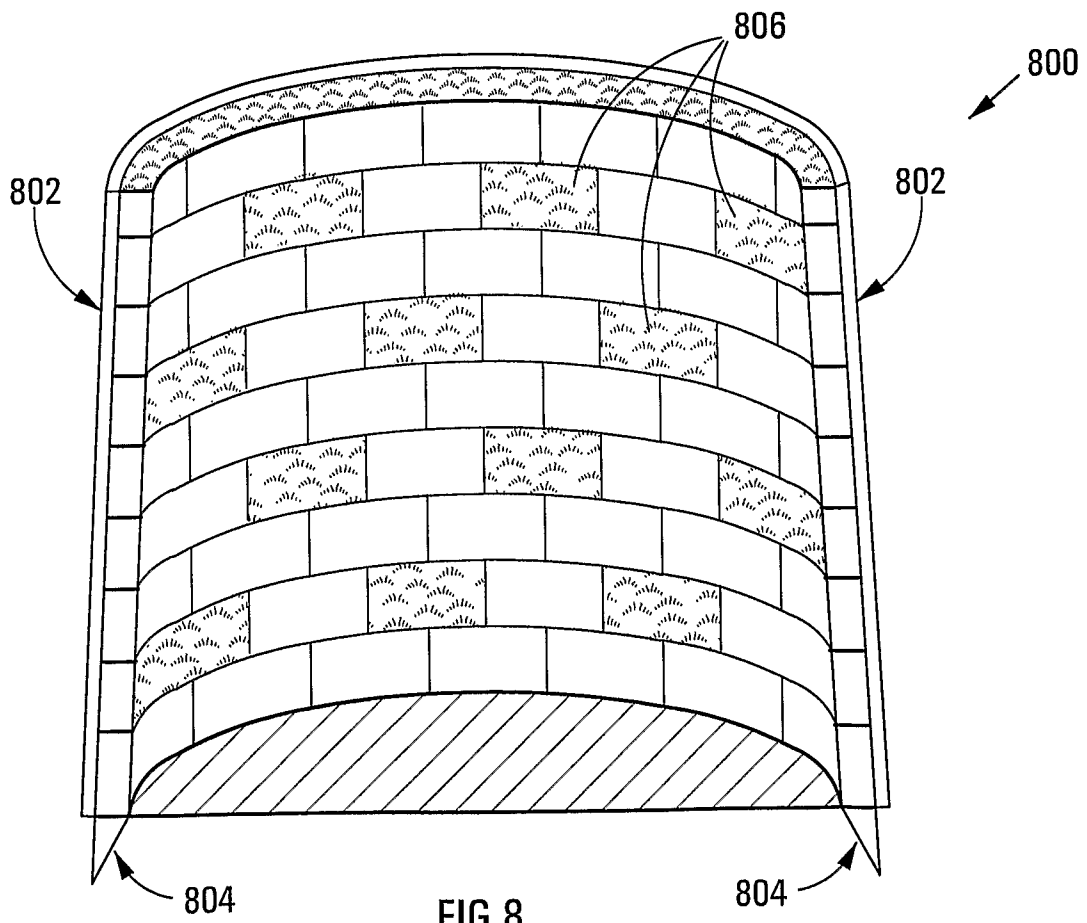
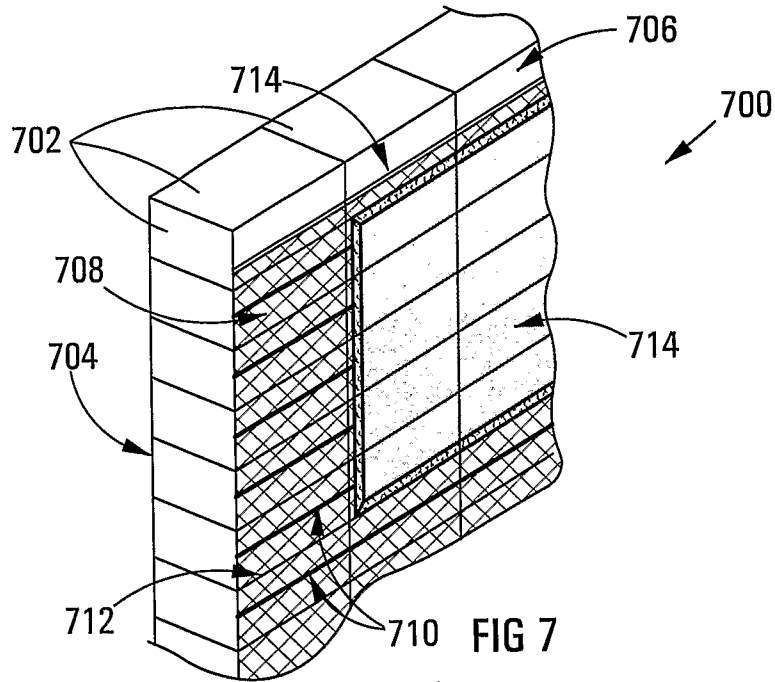


FIG 6

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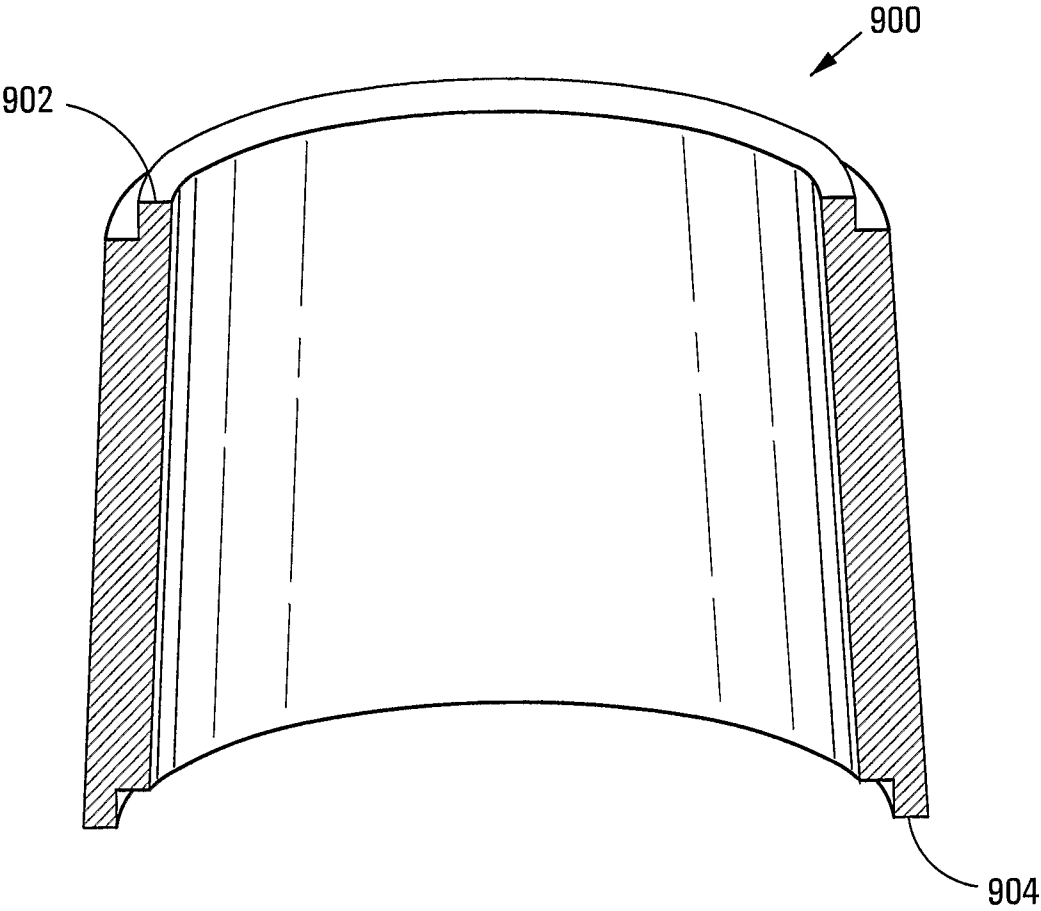


FIG 9

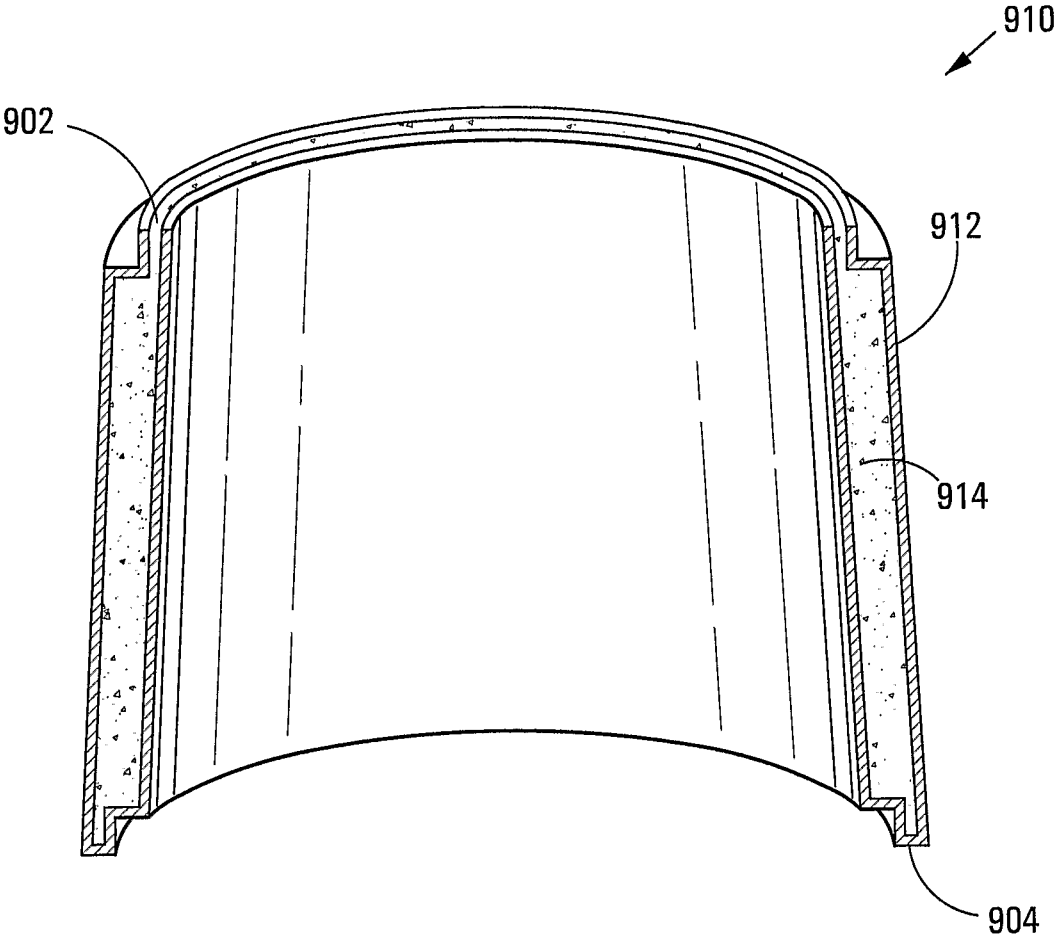


FIG 10