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(54) APPARATUS AND METHOD FOR SLIPFORMING A SHAFT

VORRICHTUNG UND VERFAHREN ZUR GLEITSCHALUNG EINER WELLE

APPAREIL ET PROCÉDÉ POUR LE COFFRAGE COULISSANT D'UN ARBRE

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(56) References cited:
DE-A1- 1 434 325 **DE-B- 1 254 851**
KR-B1- 101 021 945 **NL-C- 86 570**

- **PGP Timelapse Solutions: "Time lapse Concrete slipform Silo", , 8 April 2015 (2015-04-08), XP054979402, Retrieved from the Internet: URL:https://www.youtube.com/watch?reload=9&v=TK_G09erxqQ [retrieved on 2019-05-15]**

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Description

Technical Field

[0001] The invention relates to a slipform apparatus and a method of operating a slipform apparatus.

Background

[0002] It is known to form a vertical building or structure using slipforming, which is a construction method whereby concrete is poured into a continuously moving form to provide a cast-in-situ concrete structure. The continuously moving form is provided by platforms on an inside and an outside of the concrete structure. A workforce stands on the platforms and can place steel reinforcing rods into the concrete as required. The platforms are raised by means of hydraulic jacks that lift on steel jack rods that are cast into the concrete. Generally, the slipform concrete structure rises at a rate which permits the concrete to set and hold its own structure and weight by the time it emerges from the bottom of the form. The rate of climb is determined by the platform operator to ensure the quality of the concrete structure.

[0003] A problem with the above known slipform technique is that the concrete structure is required to have platforms on both the inside and the outside thereof. This is not possible when the concrete structure is required to be installed in a vertical shaft such as a hole in the ground. Previously this has been partially overcome by using a narrower platform of the slipform rig whilst still lifting from a steel rod that are cast within the concrete structure. However, such an arrangement is not possible when a relatively high density of reinforced bar (e.g. 300-500kgs/m3) is required for high strength concrete structures.

[0004] It is known from KR101218185 to provide an apparatus for slipforming from an inside only. Such an arrangement has a platform which is suspended on cables with winches. As the concrete hardens the platform is raised by the winches and cables. The arrangements disclosed in KR101218185 have several disadvantages. The platform disclosed therein must form the concrete and steel bar structure in a single pass due the arrangements of the platform, which require the cables that suspend the platform to be tied to an internal wall of the vertical shaft with cable stays. Furthermore the platform disclosed in KR101218185 is a solid circular shape, and cannot be used to form structures internal to the outer concrete form. Such arrangements create operational disadvantages and limit the installation options for the concrete structure.

[0005] Additionally the platform disclosed in KR101218185 may have safety disadvantages because a work force thereon may not be fully protected within an operational space of the platform. A further problem of the platform disclosed in KR101218185 is that it may not be readily adaptable to create slipform structures of different diameters because the platform has a solid circular shape.

[0006] The document NL86570C discloses a slipforming apparatus.

[0007] It is broadly an object of the present invention to address one or more of the above mentioned disadvantages of the previously known slipforming method and apparatus.

Summary

[0008] What is required is an apparatus and method which may reduce or minimise at least some of the above-mentioned problems.

[0009] According to a first aspect of the invention, there is provided a slipform apparatus for constructing a primary slipform structure from one side thereof, according to claim 1 and among other features comprising a platform having a plurality of work levels, and a lift device having at least one cable, the platform being suitable for suspending from above by said at least one cable and the lift device being operable to raise or lower the platform, wherein the plurality of work levels are provided around a perimeter of the platform and surround a central space through the plurality of work levels.

[0010] Such an apparatus provides the advantage that the plurality of work levels around a perimeter of the platform can be used to perform multiple tasks on the primary slipform structure at the same time. Furthermore, the lift device permits the platform to be raised or lower as required to perform the multiple tasks in parallel or sequentially as required. Such an arrangement may improve the operational flexibility of the platform, which may reduce the construction time and reduce costs. In addition, the central space can be used to construct additional features of the primary slipform structure. It will be understood such that each of the plurality of work levels is ring-shaped, which also means that the platform is readily adjustable in size and can be used to construct primary slipform structures of different sizes or shape, and in particular relatively large structures having a large diameter. During operation of the slipform apparatus the primary slipform structure is constructed at the perimeter of the platform, and the slipform apparatus is most useful for constructing the primary slipform structure within a shaft in the ground, although it may also be used for preparing a diaphragm wall as mentioned below.

[0011] Preferably, the apparatus does not need to be fixed in position at any time that one or more step(s) of the slipforming process is performed. Rather, a continuous raising or lowering of the platform may be performed such that one or more step(s) of the slipforming process may be performed, thereby forming a slipform structure.

[0012] Most preferably, the apparatus is lifted continuously by the lift device. That is, the lift device is configured to continuously raise or lower the platform whilst performing any or all step(s) of the slipforming process. In other words, with each pass within the shaft, the plat-

form is not required to stop such that one or more step(s) of the slipforming process can take place. Instead, the slipforming process can be carried out continuously, as the platform is raised or lowered continuously. Such a configuration allows for reduced construction time and costs. Additionally, when shuttering is present, the shuttering of the platform is not required to be removed and repositioned and affixed each time the platform is raised or lowered. The person skilled in the art will appreciate that different shaped shutters may be used, and that shutters may be added, removed or interchanged, to construct different slipform structures.

[0013] Preferably a safety barrier is provided between each work level and the central space. Such an arrangement provides the advantage that a workforce on the plurality of work levels are separated from the central space which improves safety.

[0014] Preferably each of the plurality of work levels around a perimeter of the platform comprises a regular shape. Such an arrangement allows the primary slipform structure to be created with a regular shape.

[0015] According to the invention, the lift device is provided above the platform and said at least one cable is connected to the platform. Each lift device is provided at ground level.

[0016] Such arrangements provide a convenient way of operating the lift device and coupling it to the platform, and for constructing the shaft below ground level.

[0017] Preferably the platform further comprises a portion thereof for constructing a secondary slipform structure of the primary slipform structure, the portion extending through the plurality of work levels. The ability for the platform to form such a secondary slipform structure may be useful to create additional features of the primary slipform structure, and the portion may provide additional operational advantages for the platform as mentioned below.

[0018] In one embodiment the portion of the platform comprises a part-ring shape which is suitable for forming the secondary slipform structure as a vertical tubular structure within the primary slipform structure. In one embodiment the portion of the platform comprises at least a part thereof which is planar which is suitable for forming a flat internal vertical face of the primary slipform structure. Such secondary slipform structures may be useful features of the finished concrete structure, and may provide additional functionality thereto. It will be understood that the primary slipform structure or the vertical tubular structure may have any cross section such as circular, square, rectangular hexagonal, etc. Preferably the portion is suitable for forming the secondary slipform structure comprising a duct or void in a side wall of the primary slipform structure.

[0019] Preferably the safety barrier is provided between the central space and the portion of the platform for constructing the secondary slipform structure. Such an arrangement improves safety for the workforce on the plurality of work levels.

[0020] The lift device comprises one or more winches or strand jacks, each winch or strand jack having a respective cable. Such an arrangement provides a convenient way to operate the lift device and may provide a multiple fail-safe mechanism for the slipform apparatus.

[0021] Each winch or strand jack is interconnected by a Grillage framework. That is, each of the winches and/or strand jacks are connected to one another by a Grillage framework. Such an arrangement secures the lift device in position and spreads the load across the Grillage framework, rather than the load being isolated on a specific winch and/or strand jack.

[0022] Preferably the platform has shuttering depending therefrom for containing poured concrete of the primary slipform structure until it has set, said shuttering being on one or both sides of the primary slipform structure.

[0023] Preferably, the platform includes inner shuttering and outer shuttering, wherein the inner shuttering depends from a first work level, and the outer shuttering depends from a second work level. The first and second work levels may be the same work level or different work levels. Preferably, the outer shuttering depends from a second work level via cabling. Most preferably, the outer shuttering depends from a second work level, at a deck beam thereof, by cabling. The cabling may include at least one, or a plurality of, cables secured to a work level of the platform. Such a configuration allows for easy assembly of the platform and simplifies the slipforming process, since horizontal beams depending through the rebar cage are no longer required.

[0024] In other embodiments, the inner and/or outer shuttering may depend from one or more winches. In certain embodiments, the outer shuttering may depend from one or more winches. Such inner and/or outer shuttering may be controlled by a control module, and may be controlled independently of the platform and/or the other of the inner or outer shuttering.

[0025] The inner and outer shuttering are present at equal heights with respect to the base of the shaft. That is, a distance from the base of the shaft to the inner shutter may be x and the distance from the base of the shaft to the outer shutter may be x. That is, the inner and outer shuttering are configured such that they are in a face-to-face arrangement, thereby allowing concrete to be poured therebetween.

[0026] Preferably, the platform includes at least one working level. More preferably, the platform includes a plurality of working levels. Most preferably, the platform includes at least three working levels. Even more preferably, the platform includes at least five working levels. In preferred embodiments, the platform includes exactly three or five working levels.

[0027] According to a second aspect of the invention, there is provided a method of operating a slipform apparatus according to claim 4, the method being to construct a primary slipform structure in a shaft below ground level from one side thereof, the slipform apparatus comprising

a platform having a plurality of work levels around a perimeter thereof and surrounding a central space through the plurality of work levels, and a lift device to raise or lower the platform, the method including:

suspending the platform from above using the lift device;
performing a rebar installation operation comprising raising the platform using the lift device and installing at least one rebar cage;
using the lift device to lower the platform to a base of the at least one rebar cage; and
performing a concrete slipform operation of the at least one rebar cage comprising raising the platform using the lift device.

[0028] Such a method provides the advantage that the plurality of work levels around a perimeter of the platform can be used to perform multiple tasks on the primary slipform structure at the same time. Furthermore, the lift device permits the platform to be raised or lower as required to perform the multiple tasks in parallel or sequentially as required. Such an arrangement may improve operational flexibility of the platform, which may reduce the construction time and reduce costs. In addition, the central space can be used to construct additional features of the primary slipform structure. It will be understood such that each of the plurality of work levels is ring-shaped, which also means that the platform is readily adjustable in size and can be used to construct primary slipform structures of different sizes or shape, and in particular relatively large structures having a large diameter. During operation of the slipform apparatus the primary slipform structure is constructed at the perimeter of the platform, and the slipform apparatus is most useful for constructing the primary slipform structure within a shaft in the ground.

[0029] Preferably, when carrying out the method, the apparatus does not need to be fixed in position at any time that one or more step(s) of the slipforming process is performed. Rather, a continuous raising or lowering of the platform may be performed such that one or more step(s) of the slipforming process may be performed, thereby forming a slipform structure.

[0030] Most preferably, the method includes the step of using the lift device to continuously raise or lower the apparatus. That is, the lift device may be used in any step to continuously raise or lower the platform. That is, the lift device is configured to continuously raise or lower the platform whilst performing any or all step(s) of the slipforming process. In other words, with each pass within the shaft, the platform is not required to stop such that one or more step(s) of the slipforming process can take place. Instead, the slipforming process can be carried out continuously, as the platform is raised or lowered continuously. Such a configuration allows for reduced construction time and costs. Additionally, when shuttering is present, the shuttering of the platform is not required to be removed and repositioned and affixed each time the platform is raised or lowered. The person skilled in the art will appreciate that different shaped shutters may be used, and that shutters may be added, removed or interchanged, to construct different slipform structures.

[0031] Preferably said rebar installation operation further includes using one of the plurality of work levels to install vertical reinforcing bars and another of the plurality of work levels to install horizontal reinforcing bars. Preferably said concrete slipform operation further includes using one of the plurality of work levels for pouring of the concrete and another of the plurality of work levels to finish the set concrete. Such arrangements permits different teams to perform different tasks on the plurality of work levels, which may be more efficient and reduce the construction time.

[0032] Preferably the method further includes preparing a diaphragm wall of the shaft using the platform prior to performing said rebar installation operation. Preferably said preparing the diaphragm wall comprises installing a waterproof barrier thereto. Using the platform in this way avoids the need to install additional scaffolding in the shaft to prepare the diaphragm wall prior to constructing the primary slipform structure.

[0033] Preferably the method further includes assembling the platform at a base of the shaft prior to operation thereof. Such arrangements provide a convenient way of operating the slipform apparatus.

[0034] According to the invention the lifting device comprises one or more winches or strand jacks having a respective cable, the method further including connecting each respective cable between the platform and a top of the shaft, and operating the one or more winches or strand jacks to raise or lower the platform. Such arrangements provides a convenient way of operating the lift device and coupling it to the platform.

[0035] Each winch or strand jack is interconnected by a Grillage framework. That is, each of the winches and/or strand jacks are connected to one another by a Grillage framework. Such an arrangement secures the lift device in position and spreads the load across the Grillage framework, rather than the load being isolated on a specific winch and/or strand jack.

[0036] Preferably said rebar installation operation further includes installing more than one rebar cage wherein a subsequent rebar cage is installed by lowering the platform and then raising the platform using the lift device and installing the subsequent rebar cage. Such arrangements provide for the sequential installation of subsequent rebar cages, which may be more efficient and reduce construction time and costs.

[0037] Preferably the platform further comprises a portion thereof extending through the plurality of work levels, the method further including constructing a secondary slipform structure of the primary slipform structure using the portion. The ability for the platform to form such a secondary slipform structure may be useful to create ad-

ditional features of the primary slipform structure, and the portion may provide additional operational advantages for the platform as mentioned below.

[0038] In one embodiment the portion of the platform comprises a part-ring shape, the method including constructing the secondary slipform structure from rebar as a vertical tubular structure using the part-ring shape portion, said vertical tubular structure being within the primary slipform structure. Such a secondary slipform structure may be a useful feature of the finished concrete structure, and may provide additional functionality thereto. It will be understood that the primary slipform structure or the vertical tubular structure may have any cross section such as circular, square, rectangular hexagonal, etc.

[0039] Preferably the method further includes constructing the vertical tubular structure during said rebar installation operation or during said concrete slipform operation. Such an arrangement is possible due to the plurality of work levels of the platform which allow multiple tasks to be performed at the same time, i.e. in parallel.

[0040] Preferably the method further includes performing said concrete slipform operation of the vertical tubular structure.

[0041] In one embodiment the portion of the platform comprises at least a part thereof which is planar, the method including constructing a flat internal vertical face of the primary slipform structure using the planar portion. Such a secondary slipform structure may be a useful feature of the finished concrete structure, and may provide additional functionality thereto.

[0042] Preferably the method further includes constructing the secondary slipform structure comprising a duct or void in a side wall of the primary slipform structure.

[0043] Preferably the platform has shuttering depending therefrom on one or both sides of the primary slipform structure, the method further including using said shuttering to contain the poured concrete on one or both sides of the primary slipform structure until it has set.

[0044] Preferably, the platform includes inner shuttering and outer shuttering, wherein the inner shuttering depends from a first work level, and the outer shuttering depends from a second work level. The first and second work levels may be the same work level or different work levels. Preferably, the outer shuttering depends from a second work level via cabling. Most preferably, the outer shuttering depends from a second work level, at a deck beam thereof, by cabling. The cabling may include at least one, or a plurality of, cables secured to a work level of the platform. Such a configuration allows for easy assembly of the platform and simplifies the slipforming process, since horizontal beams depending through the rebar cage are no longer required.

[0045] In other embodiments, the inner and/or outer shuttering may depend from one or more winches. In certain embodiments, the outer shuttering may depend from one or more winches. Such inner and/or outer shuttering may be controlled by a control module, and may be controlled independently of the platform and/ the other of the inner and/or outer shuttering.

[0046] The inner and outer shuttering are present at equal heights with respect to the base of the shaft. That is, a distance from the base of the shaft to the inner shutter may be x and the distance from the base of the shaft to the outer shutter may be x. That is, the inner and outer shuttering are configured such that they are in a face-to-face arrangement, thereby allowing concrete to be poured therebetween.

[0047] Preferably, the platform includes at least one working level. More preferably, the platform includes a plurality of working levels. Most preferably, the platform includes at least three working levels. Even more preferably, the platform includes at least five working levels. In preferred embodiments, the platform includes exactly three or five working levels.

[0048] According to an alternative characterisation not forming part of the invention there is provided a slipform apparatus for preparing a diaphragm wall and constructing a primary slipform structure from one side thereof, comprising a platform having one or more work levels and a lift device for suspending the platform from above and being operable to raise or lower the platform, wherein the one or more work levels are provided around an outer perimeter of the platform and surround a central space through the one or more work levels, said primary slipform structure being constructed at said outer perimeter.

[0049] According to another alternative characterisation not forming part of the invention there is provided a method of slipforming to construct a primary concrete structure in a shaft from one side thereof, the method including:

installing a plurality of rebar cages comprising installing one rebar cage in the shaft from one side and from a base thereof to a top thereof, and then installing another rebar cage adjacent to said one rebar cage from one side and from said base to said top; and

performing a concrete slipforming operation of the plurality of rebar cages comprising pouring concrete from one side and from said base to said top.

Brief Description of the Drawings

[0050] Other features of the invention will be apparent from the following description of preferred embodiments shown by way of example only with reference to the accompanying drawings, in which;

Figure 1 shows a perspective view of a pre-prepared vertical shaft in the ground;

Figure 2 shows a perspective view of a slipform apparatus with a platform at the bottom of the shaft of Figure 1 according to an embodiment of the invention;

Figure 3 shows a perspective view of the platform about halfway up the shaft during installation of an

outer rebar cage;

Figure 4 shows a perspective view of the platform at the top of the shaft after installation of the outer rebar cage;

Figure 5 shows a perspective view of the platform at the bottom of the shaft prior to installation of an inner rebar cage;

Figure 6 shows a perspective view of the platform about halfway up the shaft during installation of the inner rebar cage;

Figure 7 shows a perspective view of the platform at the top of the shaft after installation of the inner rebar cage;

Figure 8 shows a perspective view of the platform at the bottom of the shaft at the start of slipforming;

Figure 9 shows a perspective view of the platform part-way up the shaft after forming of a lower duct in a sidewall of the concrete liner;

Figure 10 shows a perspective view of the concrete liner shown in Figure 9 with the slipform apparatus omitted;

Figure 11 shows a perspective view of the platform part-way up the shaft during slipforming and during installation of a secondary rebar cage;

Figure 12 shows a perspective view of the platform part-way up the shaft after commencing formation of an additional concrete inner liner of the concrete liner;

Figure 13 shows a perspective view of the concrete liner shown in Figure 12 with the slipform apparatus omitted;

Figure 14 shows a perspective view of the platform at the top of the shaft after slipforming has been completed;

Figure 15 shows a perspective view of the completed concrete liner shown in Figure 14 with the platform removed;

Figure 16 shows a perspective cross sectional view of a part of the platform according to an embodiment of the invention;

Figure 17 shows steps of a method according to an embodiment of the invention;

Figure 18 shows a perspective cross sectional view of a part of the platform according to another embodiment of the invention;

Figure 19 shows a perspective cross sectional view of a part of the platform according to yet another embodiment of the invention;

Figure 20 shows a perspective cross sectional view of a part of the platform according to yet another embodiment of the invention;

Figure 21 shows a perspective cross sectional view of a part of the platform according to yet another embodiment of the invention; and

Figure 22 shows a perspective view of a winching system according to an embodiment of the invention.

Detailed Description

[0051] Figure 1 shows a perspective view of a pre-prepared vertical shaft 10 in the ground. The vertical shaft 10 has a pre-prepared internal wall comprising reinforced concrete piles that are driven or cut into the ground to form the vertical shaft 10. The internal wall of the vertical shaft 10 may be termed a diaphragm wall. The vertical shaft 10 also has a concrete foundation structure 11 at a base thereof. Also shown is a surface ground level at 13.

[0052] Figures 2 to 16 and 18 to 21 show stages of operating of a slipforming apparatus according to an embodiment of the invention to form a single face concrete liner 22 within the vertical shaft 10 in the ground. The concrete liner 22 may also be termed a concrete internal wall or a concrete form, and is shown to be substantially cylindrical although other shapes may be formed using the slipforming apparatus. In Figures 1 to 16 and 18 like features are shown with like reference numerals. The slipforming apparatus comprises a platform 12 suspended in the shaft 10 by cables 14, which are each coupled to a respective winch 16. The platform 12 may be alternatively termed a slipform rig. The one or more winches 16 may be alternatively termed a lift device. Whereas eight cables 14 are shown it will be appreciated that the number of cables 14 required may depend on the diameter of the shaft 10, and a larger number of cables 14 would typically be required for a shaft 10 having a larger diameter. Each winch 16 is mounted at the surface ground level 13 so that each cable 14 is substantially vertical. The platform 12 can be raised or lower by the cables and winches 14, 16 as required.

[0053] A control module (not shown) is used to ensure that the winches 16 are operated at the same time so that the raising or lowering of the platform 12 occurs at substantially the same time. In some embodiments, the control module (not shown) may operate the winches 16 such that they lift the inner and/or outer shuttering (refer to, for example, Figure 21) independently of the platform 12. This may be advantageous for, as an example, firstly providing an infill or portal, and then secondly providing a liner wall. That is, during the construction of an infill, a single shuttering (inner shuttering) may be utilised and, independently of the platform and inner shuttering, the secondary outer shuttering may be utilised to construct a liner wall. Such a constructed slipform structure is shown in Figure 21 and described further below.

[0054] In one arrangement each winch 16 comprises a mast having a boom (i.e. a crane) for carrying its respective cable 14. Each winch 16 also has a respective electric motor and cable reel arrangement (not shown) to carry the respective cable 14. As described below in relation to Figure 22, the winches 16 are interconnected through a Grillage framework.

[0055] Figure 2 shows a perspective view of the slipform apparatus with the platform 12 at the bottom of the shaft 10. It will be understood that the platform 12 is required to be assembled at a base of the shaft 10 prior to

connecting the cables 14 between the winches 16 and the platform 12. In other words, the platform 12 is required to be assembled within the vertical shaft 10 at a lowermost point thereof prior to using the platform 12. In an alternative arrangement the platform 12 is partly or fully assembled at the surface ground level 13 and suspended at a top of the shaft 10 prior to connecting the cables 14 between the winches 16 and the platform 12.

[0056] Referring briefly to Figure 16, which shows a perspective cross sectional view of a part of the platform 12, it can be seen that the platform 12 has three working levels 28, 30, 32 around a perimeter thereof. The three working levels 28, 30, 32 surround a central space generally shown at 33, which is a through hole in the three working levels 28, 30, 32. In other words the platform 12 is shown to be ring-shaped or annular such that each working level 28, 30, 32 is ring-shaped or annular whereby each working level 28, 30, 32 is a walkway around the outer perimeter of the platform 12. In the arrangement shown in Figure 16 the part of the ring-shape platform 12 is shown to be a regular ring, i.e. circular, such that the overall platform 12 with the working levels 28, 30, 32 is tubular. However, in the arrangement shown in Figure 2 to 15 the ring-shape platform 12 also has other features such as a flat portion 15 and an internal part-circular portion 17, which provide the additional operation advantages mentioned below to create additional features of the concrete liner 22. The flat portion 15 of the platform 12 may also be provided with stairs (not shown) to allow the workforce to gain access between the working levels 28, 30, 32. The flat portion 15 and the internal part-circular portion 17 extend through the plurality of working levels 28, 30, 32. It will be understood that the flat portion 15 is a planar part of the platform 12. Furthermore, the internal part-circular portion 17 is a part-cylinder or part-ring shape of the platform 12. Whereas three working levels 28, 30, 32 are shown it will be appreciated that more or less than three work levels 28, 30, 32 may be provided.

[0057] Referring back to Figure 2, after the platform 12 has been assembled at the bottom of the shaft 10 the winches 16 can be operated to raise the platform 12 to a top of the shaft to complete a first pass of the platform 12 in the shaft 10. During such a first pass the workforce on the plurality of working levels 28, 30, 32 may prepare the diaphragm wall of the shaft 10 by installing a waterproof membrane if required to provide a water barrier. After installation of the membrane the platform 12 is lowed again by the winches 16 to the lowermost point of the shaft 10 as shown in Figure 2 so that it is ready for a second pass as shown in Figure 3.

[0058] Figure 3 shows a perspective view of the platform 12 about halfway up the shaft 10 during installation of an outer rebar cage 18. The outer rebar cage 18 may be alternatively termed a far-side rebar cage. It will be understood that the outer rebar cage 18 is an outer layer of steel reinforcing bar, which may comprise three vertical layers of reinforcing bar that are close together, and which are tied together with pre-bent horizontal bars known as lacer. The outer rebar cage 18 may be termed an outer layer. Also shown is a hole 19 in the outer rebar cage 18, which is used to form a lower duct 21 in a sidewall of the concrete liner 22 as shown in Figure 10. Shuttering (not shown) around the hole 19 of the outer rebar cage 18 is also installed. The flat portion 15 of the platform 12 is useful and assists the workforce when forming the hole 19 in the outer rebar cage 18 and installing the shuttering around the hole 19. The lower duct 21 may be termed an opening. Alternatively, a void in the sidewall of the concrete liner 22 may be formed using the platform as required. The void may not necessarily be a duct.

[0059] Figure 4 shows a perspective view of the platform 12 at the top of the shaft 10 after installation of the outer rebar cage 18. On completion of the outer rebar cage 18 the platform 12 is returned to the base of the shaft 10 as shown in Figure 5 so that it is ready to install an inner rebar cage 20 as shown in Figure 6.

[0060] Figure 6 shows a perspective view of the platform 12 about halfway up the shaft 10 during installation of the inner rebar cage 20. The inner rebar cage 20 may be alternatively termed a near-side rebar cage. Also shown is the hole 19 in the outer rebar cage 18 and the inner rebar cage 20, which is used to form the lower duct 21 in the concrete liner 22 as shown in Figure 10. Shuttering (not shown) around the hole 19 of the inner rebar cage 20 is also installed. The flat portion 15 of the platform 12 is useful and assists the workforce when forming the hole 19 in the inner rebar cage 20 and installing the shuttering around the hole 19.

[0061] Figure 7 shows a perspective view of the platform 12 at the top of the shaft 10 after installation of the inner rebar cage 20. The inner rebar cage 20 may also comprise three vertical layers of reinforcing bar that are close together, and which are also tied together with pre-bent horizontal lacer bars. The inner rebar cage 20 may be termed an inner layer. Together the outer rebar cage 18 and the inner rebar cage 20 may be termed a primary rebar cage. The concrete liner 22 may be termed a primary slipform structure. A space is also provided between the outer rebar cage 18 and the inner rebar cage 20. A middle layer of reinforcing bar may also be installed in the space between the outer rebar cage 18 and the inner rebar cage 20 if required. The middle layer may be installed with the inner rebar cage 20 and may comprise links between the outer rebar cage 18 and the inner rebar cage 20. In other words the middle layer may be installed during the same pass of the platform 12 when installing the inner rebar cage 20 such that the inner rebar cage 20 and the middle rebar cage comprise one rebar cage. On completion of the inner rebar cage 20 the platform 12 is returned to the base of the shaft 10 as shown in Figure 8 so that it is ready to start the step of slipforming, i.e. pouring of concrete.

[0062] Figure 8 shows a perspective view of the platform 12 at the bottom of the shaft 10 at the start of slipforming of the concrete liner 22. As shown in Figure 8 the platform 12 is just above the base of the shaft 10 after

slipforming has commenced whereby the concrete liner 22 is formed directly onto the concrete foundation structure 11. It will be appreciated that the concrete is poured from the surface 13 via a pipe (not shown).

[0063] Figure 9 shows a perspective view of the platform 12 when it is part-way up the shaft 10 after forming of the lower duct 21 in the sidewall of the concrete liner 22, which is shown in Figure 10 with the platform 12 omitted for clarity. The flat portion 15 of the platform 12 is useful and assists the workforce when installing rebar and shuttering to form the lower duct 21 as shown in Figure 10. Figures 9 and 10 show the concrete liner 22 at about 9.5m in height.

[0064] Figure 11 shows a perspective view of the platform 12 when it is part-way up the shaft 10 during slipforming and during installation of a secondary rebar cage 24, which is a tubular structure of reinforcing bar that may be used to form an additional inner concrete liner 26 if required as shown in Figure 13. The additional inner concrete liner 26 may be termed a secondary slipform structure. The secondary rebar cage 24 is tied to the inner rebar cage 20 using links. As shown in Figure 11 the secondary rebar cage 24 is inside the primary rebar cage 18, 20 such that each of the primary rebar cage 18, 20 and the secondary rebar cage 24 are cylindrical and have axes which are substantially parallel and not coaxial. It will also be appreciated that due to the multiple levels 28, 30, 32 of the platform 12 it is possible to assemble the secondary rebar cage 24 during slipforming of the concrete liner 22. As shown in Figure 11 the internal part-circular portion 17 of the platform 12 surrounds the secondary rebar cage 24, and is useful because it assists the workforce to form the secondary rebar cage 24. Furthermore the internal part-circular portion 17 is useful because it assist when pouring the concrete around the additional inner concrete liner 26. In this manner the slipforming apparatus according the embodiments disclosed herein can be used to create a concrete liner 22 having an additional internal structure such as the lower duct 21 and the additional inner concrete liner 26.

[0065] Figure 12 shows a perspective view of the platform 12 when it is part-way up the shaft 10 after commencing formation of the additional inner concrete liner 26 of the concrete liner 22, which is shown in Figure 13 with the platform 12 omitted for clarity. The inner concrete liner 26 may be used to house steel vent pipework if required to be installed in the shaft 10. As shown in Figure 13 a base 27 of the inner concrete liner 26 is part-way up the concrete liner 22, and the inner concrete liner 26 and the concrete liner 22 are formed as one during the slipforming process. Figures 12 and 13 show the concrete liner 22 at about 21.7m in height. The internal part-circular portion 17 of the platform 12 is useful and assists the workforce when installing shuttering (not shown) to form the base 27 and the internal walls of the inner concrete liner 26. The concrete liner 22 or the inner concrete liner 26 may have any cross section such as circular, square, rectangular hexagonal, etc with a through hole.

[0066] Figure 14 shows a perspective view of the platform 12 at the top of the shaft 10 after slipforming of the concrete liner 22 has been completed. Figure 15 shows a perspective view of the completed concrete liner 22 shown in Figure 14 with the platform 12 removed. As shown in Figure 14 a top 29 of the inner concrete liner 26 ends before a top 31 of the concrete liner 22. Figures 14 and 15 show the concrete liner 22 at about 47.0m in height. It will be appreciated that the base 27 and the top 29 of the inner concrete liner 26 may be extended to the base and the top of the concrete liner 22 if required.

[0067] Referring again to Figure 16, also shown is that each level 28, 30, 32 has an internal safety wall 34, 36, 38 to fully enclose the work force at each level 28, 30, 32 so that they are separated from the central space 33. The internal safety wall 34, 36, 38 also extends around the flat portion 15 and the internal part-circular portion 17 mentioned above. Each safety wall 34, 36, 38 comprises a vertical panel or fence between each level 28, 30, 32 and the central space 33. Such an arrangement provides an improved safety for the work force on the levels 28, 30, 32. It will be understood that each level 28, 30, 32 comprises a substantially horizontal walkway, which may be of any suitable material such a wood. Each level 28, 30, 32 is supported by a plurality of deck beams 35, which extend in a radial direction of the platform 12 and are spaced around the perimeter of the platform 12. Only the top deck beam 35 for the top level 28 is shown, but it will be understood that middle deck beams are provided for the middle level 30, and lower deck beams are provided for the lower level 32. Each safety wall 34, 36, 38 is hung on posts 39 which are connected to a respective deck beam. Shuttering 40 is also shown below the middle level 30 so that the concrete liner 22 can be formed when concrete is poured at the middle level 30. It will be understood that the shuttering 40 depends around an outer perimeter of the platform 12. In the embodiment shown the shuttering 40 depends from the middle level 30. The shuttering 40 also depends from the middle level 30 at the flat portion 15 and around the internal part-circular portion 17. The shuttering may be any suitable panel to contain the poured concrete until it has set. Vertical beams 42 are also shown between adjacent deck beams of the levels 28, 30, 32.

[0068] From the foregoing description it can be seen that the central space 33 of the platform 12 provides an advantage that the additional concrete structures such as the lower duct 21 and the inner concrete liner 26 (see Figures 10 and 15) can be formed. Furthermore the three working levels 28, 30, 32 permit different teams of workers to install different parts of the inner and outer cages 18, 20 as discussed above. For example, one team on the upper level 32 may install vertical reinforcing bars, another team on the middle level 30 may install pre-bent horizontal lacer bars, and another team on a lower level 28 may also install horizontal lacer bars. In another example, the concrete may be poured at the middle level 30 by one team, and another team on the lower level 28

may finish the set concrete surface by hand trowelling or brush finishing, and optionally another team on the upper level 32 may install the secondary rebar cage 24. Each of the three working levels 28, 30, 32 is about 3m in height such that the overall platform 12 is about 9m in height. Such an arrangement permits relatively long twelve meter vertical rebar to be used when installing the rebar cages 18, 20, 24, which may help to reduce the time to construct the primary and secondary rebar cages. Furthermore, since there are three working levels 28, 30, 32 are larger workforce can operate on the platform 12 at a given time, which may further help to reduce the time of construction.

[0069] Figure 17 shows steps of a method according to an embodiment of the invention, generally designated 50. It will be appreciated that the steps may be performed in a different order, and may not necessarily be performed in the order shown in Figure 17. The method 50 is for operating a slipform apparatus to construct a primary slipform structure 22 in a shaft 10 from one side thereof, the slipform apparatus comprising a platform 12 having a plurality of work levels 28, 30, 32 around a perimeter thereof and surrounding a central space 33 through the plurality of work levels 28, 30, 32, and a lift device 14, 16 to raise or lower the platform 12. The method includes suspending the platform 12 from above using the lift device 14, 16, performing a rebar installation operation comprising raising the platform using the lift device 14, 16 and installing at least one rebar cage 18, 20, using the lift device 14, 16 to lower the platform 12 to a base of the at least one rebar cage 18, 20, and performing a concrete slipform operation of the at least one rebar cage 18, 20 comprising raising the platform 12 using the lift device 14, 16, as shown at 52.

[0070] The method includes using one of the plurality of work levels 28, 30, 32 for one construction operation and another of the plurality of work levels 28, 30, 32 for another construction operation, as shown at 54. For example, the rebar installation operation further includes using one of the plurality of work levels 28, 30, 32 to install vertical reinforcing bars and another of the plurality of work levels 28, 30, 32 to install horizontal reinforcing bars, as shown at 54. For example, the concrete slipform operation further includes using one of the plurality of work levels 28, 30, 32 for pouring of the concrete and another of the plurality of work levels to finish the set concrete, as shown at 54.

[0071] The method further includes preparing a diaphragm wall of the shaft 10 using the platform 12 prior to performing said rebar installation operation, as shown at 56. The preparing of the diaphragm wall comprises installing a waterproof barrier thereto. The method further includes assembling the platform 12 at a base of the shaft prior to operation thereof, as shown at 58.

[0072] The lifting device comprises one or more winches or strand jacks 16 having a respective cable 14, the method further including connecting each respective cable 14 between the platform 12 and a top of the shaft 10, and operating the one or more winches or strand jacks 16 to raise or lower the platform 12, as shown at 60.

[0073] The rebar installation operation further includes installing more than one rebar cage 18, 20 wherein a subsequent rebar cage is installed by lowering the platform 12 and then raising the platform 12 using the lift device 14, 16 and installing the subsequent rebar cage, as shown at 62.

[0074] The platform further comprises a portion thereof extending through the plurality of work levels, the method further including constructing a secondary slipform structure of the primary slipform structure using the portion, as shown at 64.

[0075] In one arrangement the portion of the platform 12 comprises a part-ring shape 17, the method including constructing the secondary slipform structure from rebar as a vertical tubular structure 24 using the part-ring shape portion 17, said vertical tubular structure 24 being within the primary slipform structure 22, as shown at 64. The method further includes constructing the vertical tubular structure 24 during said rebar installation operation or during said concrete slipform operation, as shown at 64. The method further includes performing said concrete slipform operation of the vertical tubular structure 24, as shown at 64.

[0076] In one arrangement the portion of the platform comprises at least a part thereof which is planar 15, the method including constructing a flat internal vertical face of the primary slipform structure 22 using the planar portion 15, as shown at 64. The method further includes constructing the secondary slipform structure comprising a duct 21 in a side wall of the primary slipform structure 22, as shown at 64.

[0077] Figure 18 shows a perspective cross sectional view of a part of the platform 12 according to another embodiment of the invention. The cables 14 for suspending the platform 12 have been omitted for clarity in Figure 18. The platform 12 shown in Figure 18 is similar to the platform 12 of Figure 16 apart from additional outer shuttering 41, which is on the other side of the concrete liner 22 to the shuttering 40. In Figure 18 the shuttering 40 may be termed inner shuttering, and the concrete liner 22 is formed between the inner shuttering 40 and the outer shuttering 41 with the platform 12 being substantially at one side of the concrete liner 22. In the embodiment shown the outer shuttering 41 is at or just below the middle level 30 so that the concrete liner 22 can be formed when concrete is poured at the middle level 30. The outer shuttering 41 depends around an outer perimeter of the platform 12 so that it depends at or just below the middle level 30. The outer shuttering 41 also depends from the middle level 30 at the flat portion 15 and around the internal part-circular portion 17 discussed above. The outer shuttering 41 may be any suitable panel to contain the poured concrete until it has set. The outer shuttering 41 is connected to an outer vertical beam 45. The outer vertical beam 45 is connected to upper and lower horizontal beams 43, which are both connected to the vertical

beams 42 at the middle level 30. In this manner the outer shuttering 41 moves as the platform 12 is moved. The upper and lower horizontal beams 43 pass through the outer and inner rebar cages 18, 20 and are not impeded by the pre-bent horizontal lacer bars as they are moved upwards. The pre-bent horizontal lacer bars may be installed on the outer and inner rebar cages 18, 20 at the middle level 30 underneath the lower horizontal beam 43 and before the pouring of concrete commences.

[0078] It will be understood that the outer shuttering 41 is between the concrete liner 22 and the diaphragm wall of the shaft 10, and permits an outer surface of the concrete liner 22 to be finished at least to some degree, although it will be understood that the outer surface of the concrete liner 22 is not hand trowelled or brush finished. A space 47 is formed between the concrete liner 22 and the diaphragm wall of the shaft 10, which may be backfilled with aggregate from above if required.

[0079] It will also be understood that the slipform apparatus shown in Figure 18 is suitable for constructing a primary slipform structure (i.e. one or more rebar cages 18, 20, and the concrete liner 22) substantially from one side thereof albeit that the outer shuttering 41 is on another side of the primary slipform structure. Whereas the inner and outer shuttering 40, 41 is shown to depend from the middle level 30 it may alternatively depend from any level of the platform 12.

[0080] Referring to Figure 19, a perspective cross sectional view of another embodiment of the platform 12 is shown. The cables 14 for suspending the platform 12 have been omitted for clarity in Figure 19. As described in relation to Figure 16, it can be seen that the platform 12 has three working levels 28, 30, 32 around a perimeter thereof. The three working levels 28, 30, 32 surround a central space generally shown at 33, which is a through hole in the three working levels 28, 30, 32. In other words, the platform 12 is shown to be ring-shaped or annular such that each working level 28, 30, 32 is ring-shaped or annular whereby each working level 28, 30, 32 is a walkway around the outer perimeter of the platform 12. In the arrangement shown in Figure 19, the part of the ring-shape platform 12 is shown to be a regular ring, i.e. circular, such that the overall platform 12 with the working levels 28, 30, 32 is tubular. However, as shown in the arrangement of Figures 2 to 15, the ring-shape platform 12 of this embodiment may also has other features such as a flat portion 15 and an internal part-circular portion 17. It will also be appreciated by the person skilled in the art that the platform 12 of Figure 19 may have more or less working levels, for example, one, two, three, four, five or more working levels.

[0081] The platform 12 of Figure 19 is similar in construction to the platforms of Figures 16 and 18. That is, the platform 12 of Figure 19 includes a plurality of working levels 28, 30, 32 interconnected by vertical beams 42. The platform includes internal safety walls 34, 36, 38 provided on each of the respective working levels 28, 30, 32 to fully enclose the work force at each working level 28, 30, 32. The internal safety walls 34, 36, 38 also extend around the flat portion 15 and the internal part-circular portion 17 (refer to Figures 2 to 15). The internal safety walls 34, 36, 38 comprise a vertical panel of fence between each level 28, 30, 32 and the central space 33. The internal safety walls 34, 36, 38 are each hung by posts 39 on their respective working levels 28, 30, 32. Such an arrangement provides an improved safety for the work force on levels 28, 30, 32. It will be understood that each level 28, 30, 32 comprises a substantially horizontal walkway, which may be of any suitable material, such as wood. Each working level 28, 30, 32 is supported by a plurality of deck beams 35, which extend in a radial direction of the platform 12 and are spaced around the perimeter of the platform 12. For clarity, only the top deck beam 35 of top level 28 is shown in Figure 19. As described above in relation to platforms of Figures 16 and 18, the platform 12 of Figure 19 is connected by cables (not shown) to winches (not shown) such that a slipforming process can take place.

[0082] The platform 12 is shown as having single shuttering 40. In the embodiment shown, the shuttering 40 is at or just below the middle level 30 so that the concrete liner 22 can be formed when concrete is poured at the middle level 30. The single shuttering 40 can depend directly from the middle level 30 by connection to the working level 30 via the vertical beam 42. In alternative embodiments, not shown, the single shuttering 40 may depend from another working level by other means, for example, the shuttering 40 may depend from a deck beam by cabling.

[0083] In the depicted embodiment, the concrete liner 22 is formed without a space (refer to Figure 18, space 47) between the concrete liner 22 and the shaft 10. That is, in the depicted embodiment, the concrete liner 22 is formed as an infill at the working surface, or diaphragm wall, of shaft 10. The shuttering 40 may be any suitable panel to contain the poured concrete until it has set, as described previously.

[0084] It will also be understood that the slipform apparatus shown in Figure 19 is suitable for constructing a primary slipform structure (i.e. one or more rebar cages (not shown) and the concrete liner 22) substantially from one side thereof. Whereas the shuttering 40 is shown to depend from the middle level 30, it may alternatively depend from any level of the platform 12.

[0085] Referring to Figure 20, a perspective cross sectional view of another embodiment of the platform 12 is shown. The cables 14 for suspending the platform 12 have been omitted for clarity in Figure 20. The shaft 12 of Figure 20 is most similar to that as described in relation to Figure 19, and technical elements described in Figure 19 apply equally to those having like reference numerals in Figure 20, and are as described above. The difference between the embodiments of Figures 19 and 20 is that the shaft 12 of Figure 20 operates further inwards, that is, further towards the central axis of the shaft 10 (i.e. further away from the working surface of shaft 10). In

some embodiments, the platform 12 may have a diameter sized such that a desired infill is achieved. In the embodiment of Figure 20, a greater infill i.e. a thicker concrete liner 22, can be achieved. The principles and the construction of the shaft 12 of Figure 20 is the same as those described in Figures 2 to 16, 18 and 19.

[0086] Referring now to Figure 21, there is described yet another embodiment of the shaft 12. The shaft 12 of Figure 21 is similar in construction to that described in Figures 16, 18, 19 and 20, but also includes additional working levels. The same technical elements described in Figures 16 and 18 to 20 apply equally to those having like reference numerals in Figure 21, and are as described above.

[0087] It is also noted that the concrete liner 22 may be formed in two stages, the first stage being that shown in Figures 19 and 20, and the second stage being that shown in Figure 21. That is, firstly, an infill may be constructed in accordance with Figures 19 and 20, and secondly, a concrete liner may be formed using the shuttering described below. The construction of such a concrete liner may involve a platform having any construction, whether that is shape, size or number of working levels, as described herein.

[0088] Figure 21 shows a fourth working level 70 and a fifth working level 72 including internal safety walls 74, 76 hung on posts 39 to enclose the work force on the respective fourth and fifth working levels 70, 72. The additional working levels 70, 72 may be constructed in a similar or the same manner as those working levels 28, 30, 32 described above. In this way, the platform 12 includes five working levels 28, 30, 32, 70, 72. Such a configuration provides more flexibility for the users of the platform, in that multiple tasks may be performed on the primary slipform structure at the same time. For example, the additional working levels 70, 72 may permit different teams of workers to installer different aspects of the slipform structure, for example, the inner and outer rebar cages 18, 20, as shown in Figure 21.

[0089] The embodiment of Figure 21 may employ the construction and/or shuttering of any other described embodiment. For example, the shaft 12 of Figure 21 may include a single shutter (refer to Figure 19 and 20 in particular) or may include inner and outer shuttering 40, 41 as shown in Figure 21. Additionally, the inner and outer shuttering 40, 41 may be constructed in a similar manner to that described in Figure 18, or, alternatively, may be constructed in a manner as described below referring to the specific embodiment of Figure 21.

[0090] As can be seen in Figure 21, the inner shuttering 40 depends from a second working level 30. However, as will be appreciated by the person skilled in the art, the inner shuttering 40 may depend from any one of the working levels 28, 30, 32, 70, 72. The outer shuttering 41 of Figure 21 is shown as depending from the fifth working level 72, preferably at a deck beam 78, via cabling 80. Again, it will be appreciated that the outer shuttering 41 may depend from any of the working levels 28, 30, 32, 70, 72. As shown in Figure 21, the use of cabling 80 negates the need for horizontal beams depending through rebar cages 18, 20, as shown in Figure 18. Alternatively, the inner and/or outer shuttering 40, 41 may depend such that it can be controlled independently of the platform 12. For example, the inner and/or outer shuttering 40, 41 may depend from winches (not shown) that are controlled independently of winches (not shown) that suspend the platform.

[0091] The additional working levels 70, 72 allow the outer rebar 18 to be installed prior to the inner rebar 16. In this way, the rebar 16, 18 can be installed without the need for extra splicing of rebar 16, 18, thus reducing labour requirements to install such rebar 16, 18. Such a construction of the platform 12 allows for safe and economic installation of rebar 16, 18.

[0092] It will be appreciated by the person skilled in the art that the cabling 80 may include any number of cables, having the desired properties (i.e. materials, diameter, etc.) appropriate for use in this context. The person skilled in the art would also appreciate that the construction of this embodiment applies equally to platforms having any number of working levels, for example, one, two, three, four, five or more working levels.

[0093] Finally, Figure 22 shows an embodiment of a lift device 100 for raising or lowering a platform 12 as described in any one of the above embodiments. The lift device 100 includes one or more winches 116 and associated cables 114 for suspending the platform (not shown) during the construction of a primary slipform structure 122.

[0094] As described above, a control module (not shown) is used to ensure that the winches 116 are operated at the same time so that the raising or lowering of the platform (not shown) occurs at substantially the same time. In some embodiments, the control module (not shown) may operate the winches 116 such that they lift the inner and/or outer shuttering (refer to, for example, Figure 21) independently of the platform (not shown). This may be advantageous for, as an example, firstly providing an infill or portal, and then secondly providing a liner wall. That is, during the construction of an infill, a single shuttering (inner shuttering) is utilised and, independently of the platform and inner shuttering, the secondary outer shuttering is utilised to construct a liner wall. Such a constructed slipform structure is shown in Figure 21.

[0095] In one arrangement each winch 116 comprises a mast having a boom (i.e. a crane) for carrying its respective cable 114. Each winch 116 also has a respective electric motor and cable reel arrangement (not shown) to carry the respective cable 114. In the depicted embodiment, the lift device 100 includes a Grillage framework 101 interconnecting each of the winches 116, thereby securing the lift device 100.

[0096] The above embodiments described herein provide the advantage that the platform 12 can be raised or lower as required to allow the full installation of all rebar

and void formwork (i.e. shuttering) to be installed and checked so that it can be inspected and signed off prior to commencement of pouring the concrete. Furthermore, the embodiments described herein permit additional tasks to be performed such as installation of a waterproof liner to the diaphragm wall or additional preparation of the diaphragm wall. This removes to need for other access platforms or full scaffold installation into the shaft 10 to install the waterproofing prior to installation of the inner and outer layers 18, 20 of reinforcing bar, or installation of the inner concrete liner 26. Accordingly, the platform 12 permits a high degree of operational flexibility, which saves time and money to construct the concrete structure 22. Furthermore, the embodiments described herein permit the concrete placement to be completed in an uninterrupted manner from a base of the shaft 10 to a top thereof.

[0097] The above embodiments permit the concrete forms 22, 26 to be made with a higher finished quality, and also reduce the overall construction time for the concrete forms 22, 26, which reduces the cost of construction. For example, the prior art method of constructing the concrete forms 22, 26 may take about twenty weeks, whereas using the apparatus and method of the above embodiment of the invention may reduce the constructing time of the concrete forms 22, 26 to about ten weeks.

[0098] The above embodiments relate to an apparatus and method to form a concrete structure in a vertical shaft where access is only available from one side thereof. In particular the apparatus and method relate to the lifting/lowering of the platform 12 when suspended from a top of shaft to prepare the diaphragm wall, install one or more rebar cages for additional rebar structures of the concrete liner 22, pour the concrete, and finish the concrete. In the above embodiments the winches 16 are shown to be at the surface 13, but in an alternative arrangement the winches 16 could be mounted on the platform 12 such that the upper end of each cable 14 is tethered at the surface 13 or at a top of the shaft 10.

[0099] In the above embodiments described herein with reference to Figures 2 - 16, 18 and 21, the rebar cages 18, 20, 24 are illustrated with 25% density for the purposes of clarity. However, the real-world embodiments would have 100% or more to provide the required strength for the finished concrete liners 22, 26.

[0100] It will be understood from the foregoing that the installation of the rebar cages 18, 20, 24 is performed during a respective lift operation (i.e. lifting of the platform 12 from a lower point to a higher point). In other words, the outer rebar cage 18 is installed from the platform 12 as it is raised from a lower point to a higher point, then the platform 12 is lowered again before installing the inner rebar cage 20 from the platform 12 is it raised from a lower point to a higher point, then the platform 12 is lowered again before pouring the concrete to form the concrete liner 22, and then the rebar cage 24 is installed from the platform 12 is it raised from a lower point to a higher point whilst pouring the concrete. As such it will be understood that certain operations such as the installation of the outer rebar cage 18 followed by the installation of the inner rebar cage 20 are performed sequentially (i.e. one after the other), whereas other operations such as the pouring of concrete and the installation of the additional rebar cage 24 can be performed in parallel (i.e. at the same time). Such an arrangement provides greater operational flexibility for the slipform apparatus according to the embodiments described herein.

[0101] Whereas the internal portion 17 of the platform 12 is shown to be part-circular it will be appreciated that any other shape for the internal portion 17 may be used as require to provide an alternative shape for the additional inner concrete liner 26. Furthermore, the additional inner concrete liner 26 may be a solid form so that it is non-tubular, or it may have a through-hole as shown in Figures 13 and 15 such that is it tubular. Where the additional inner concrete liner 26 is tubular it will be appreciated that the internal portion 17 of the platform 12 is required to be ring-shaped (or part-ring shaped) having a central hole.

[0102] The above embodiments describe the use of one or more winches 16, 116 for lifting the platform 12 with the cables 14, 114. In an alternative arrangement one or more strand jacks are used in place of the winches 16, 116. It will be understood that the any suitable lifting device may be used with the above embodiments such as winches or strand jacks that use the cables 14, 114 with the proviso that the lifting device has a sufficient lifting capacity to lift the platform 12 by the cables 14, 114. A Grillage framework 101 is utilised with any embodiment of the lift device 100, irrespective of the type or quantity of winches 16, 116 employed.

Claims

1. A slipform apparatus for constructing a primary slipform structure from one side thereof, the structure being a shaft below ground level, the apparatus comprising a platform (12) having a plurality of work levels (28, 30, 32), and a lift device having at least one cable (14), the lift device comprising one or more winches (16) or strand jacks, each winch (16) or strand jack having a respective cable (14); the platform being suitable for suspending from above by said at least one cable (14) and the lift device being operable to raise or lower the platform (12), wherein the plurality of work levels (28, 30 32) are provided around a perimeter of the platform (12) and surround a central space (33) through the plurality of work levels (28, 30, 32); **characterised in that** each winch (16) or strand jack being interconnected by a Grillage framework (101), and wherein the lift device is provided at ground level above the platform and at least one said cable is connected to the platform.

2. A slipform apparatus according to the preceding

claim, wherein the platform (12) further comprises a portion (17, 15) thereof for constructing a secondary slipform structure of the primary slipform structure, the portion extending through the plurality of work levels (28, 30, 32),

wherein the portion (17) of the platform (12) comprises a part-ring shape which is suitable for forming the secondary slipform structure as a vertical tubular structure within the primary slipform structure; or
wherein the portion (17) of the platform comprises at least a part thereof which is planar (15) which is suitable for forming a flat internal vertical face of the primary slipform structure; and
wherein the portion (15) is suitable for forming the secondary slipform structure comprising a duct or void in a side wall of the primary slipform structure.

3. A slipform apparatus according to any preceding claim, wherein the platform (12) has shuttering (40) depending therefrom for containing poured concrete of the primary slipform structure until it has set, said shuttering (40, 41) being on one or both sides of the primary slipform structure that includes inner shuttering (40) and outer shuttering (41), wherein the inner shuttering (40) depends from a first work level (28, 30, 32), and the outer shuttering (41) depends from a second work level (28,30, 32) via cabling.

4. A method of operating a slipform apparatus to construct a primary slipform structure in a shaft (10) below ground level from one side thereof, the slipform apparatus comprising a platform (12) having a plurality of work levels (28, 30, 32) around a perimeter thereof and surrounding a central space (33) through the plurality of work levels (28, 30, 32), and a lift device to raise or lower the platform (12), the lift device comprises one or more winches (16) or strand jacks, each winch (16) or strand jack having a respective cable (14), each winch (16) or strand jack being interconnected by a Grillage framework (101), and wherein the lift device is provided at ground level above the platform and at least one said cable is connected to the platform; the method including:

suspending the platform (12) from above using the lift device;
performing a rebar installation operation comprising raising the platform (12) using the lift device and installing at least one rebar cage (18, 20);
using the lift device to lower the platform (12) to a base of the at least one rebar cage (18, 20); and
performing a concrete slipform operation of the at least one rebar cage (18, 20) comprising raising the platform (12) using the lift device.

5. A method according to claim 4, wherein said rebar installation operation further includes using one of the plurality of work levels (28, 30, 32) to install vertical reinforcing bars and another of the plurality of work levels to install horizontal reinforcing bars.

6. A method according to claim 4 or 5, wherein said concrete slipform operation further includes using one of the plurality of work levels (28, 30, 32) for pouring of the concrete and another of the plurality of work levels (28, 30, 32) to finish the set concrete.

7. A method according to any of claims 4 to 6, and further including preparing a diaphragm wall of the shaft (10) using the platform (12) prior to performing said rebar installation operation, wherein said preparing the diaphragm wall comprises installing a waterproof barrier thereto.

8. A method according to any of claims 4 to 7, wherein the method further including:

connecting each respective cable (14) between the platform and a top of the shaft (10), and
operating the one or more winches (16) or strand jacks to raise or lower the platform (12).

9. A method according to any of claims 4 to 8, wherein said rebar installation operation further includes installing more than one rebar cage (18, 20) wherein a subsequent rebar cage (18, 20) is installed by lowering the platform (12) and then raising the platform (12) using the lift device and installing the subsequent rebar cage (18, 20).

10. A method according to any of claims 4 to 9, wherein the platform (12) further comprises a portion (17) thereof extending through the plurality of work levels (28, 30, 32), the method further including constructing a secondary slipform structure of the primary slipform structure using the portion (17).

11. A method according to claim 10, wherein the portion (17) of the platform comprises a part-ring shape, the method including constructing the secondary slipform structure from rebar as a vertical tubular structure using the part-ring shape portion (17), said vertical tubular structure being within the primary slipform structure,

and further including constructing the vertical tubular structure during said rebar installation operation or during said concrete slipform operation;
and further including performing said concrete slipform operation of the vertical tubular struc-

ture.

12. A method according to claim 10, wherein the portion (15) of the platform comprises at least a part (15) thereof which is planar, the method including constructing a flat internal vertical face of the primary slipform structure using the planar portion (15).

13. A method according to any of claims 10 to 11, and further including constructing the secondary slipform structure comprising a duct or void in a side wall of the primary slipform structure.

14. A method according to any of claims 4 to 13, wherein the platform (12) has shuttering (40, 41) depending therefrom on one or both sides of the primary slipform structure that includes inner shuttering (40) and outer shuttering (41), wherein the inner shuttering (40) depends from a first work level (28, 30, 32), and the outer shuttering (41) depends from a second work level (28, 30, 32) via cabling, the method further including using said shuttering (40, 41) to contain the poured concrete on one or both sides of the primary slipform structure until it has set.

Patentansprüche

1. Eine Gleitschalungsvorrichtung zum Erbauen einer primären Gleitschalungsstruktur von einer Seite davon, wobei die Struktur ein Schacht unter der Erdoberfläche ist, wobei die Vorrichtung eine Plattform (12) mit einer Vielzahl von Arbeitsebenen (28, 30, 32) und eine Hebevorrichtung mit mindestens einem Seil (14) beinhaltet, wobei die Hebevorrichtung eine oder mehrere Winden (16) oder Litzenheber beinhaltet, wobei jede Winde (16) oder jeder Litzenheber ein entsprechendes Seil (14) aufweist; wobei die Plattform geeignet ist, von oben durch das mindestens eine Seil (14) aufgehängt zu werden, und die Hebevorrichtung betätigt werden kann, um die Plattform (12) anzuheben oder abzusenken, wobei die Vielzahl von Arbeitsebenen (28, 30, 32) um einen Umfang der Plattform (12) herum bereitgestellt sind und einen zentralen Raum (33) durch die Vielzahl von Arbeitsebenen (28, 30, 32) umgeben; **dadurch gekennzeichnet, dass** jede Winde (16) oder jeder Litzenheber durch ein Gitterrost-Gerüst (101) miteinander verbunden ist, und wobei die Hebevorrichtung an der Erdoberfläche über der Plattform bereitgestellt ist und mindestens ein derartiges Seil mit der Plattform verbunden ist.

2. Gleitschalungsvorrichtung gemäß dem vorhergehenden Anspruch, wobei die Plattform (12) ferner einen Abschnitt (17, 15) davon zum Erbauen einer sekundären Gleitschalungsstruktur der primären Gleitschalungsstruktur beinhaltet, wobei sich der Abschnitt durch die Vielzahl von Arbeitsebenen (28, 30, 32) erstreckt,

wobei der Abschnitt (17) der Plattform (12) eine Teilringform beinhaltet, die geeignet ist, die sekundäre Gleitschalungsstruktur als eine vertikale röhrenförmige Struktur innerhalb der primären Gleitschalungsstrukturzu bilden; oder
wobei der Abschnitt (17) der Plattform mindestens einen Teil davon beinhaltet, der eben (15) ist, was zum Bilden einer flachen inneren vertikalen Fläche der primären Gleitschalungsstruktur geeignet ist; und
wobei der Abschnitt (15) geeignet ist, die sekundäre Gleitschalungsstruktur zu bilden, die einen Kanal oder Hohlraum in einer Seitenwand der primären Gleitschalungsstruktur beinhaltet.

3. Gleitschalungsvorrichtung gemäß einem vorhergehenden Anspruch, wobei die Plattform (12) eine von ihr herabhängende Schalung (40) aufweist, um gegossenen Beton der primären Gleitschalungsstruktur aufzunehmen, bis er abgebunden hat, wobei sich die Schalung (40, 41) auf einer oder beiden Seiten der primären Gleitschalungsstruktur befindet, die eine innere Schalung (40) und eine äußere Schalung (41) umfasst, wobei die innere Schalung (40) von einer ersten Arbeitsebene (28, 30, 32) herabhängt und die äußere Schalung (41) über eine Verkabelung von einer zweiten Arbeitsebene (28, 30, 32) herabhängt.

4. Ein Verfahren zum Betätigen einer Gleitschalungsvorrichtung zum Erbauen einer primären Gleitschalungsstruktur in einem Schacht (10) unter der Erdoberfläche von einer Seite davon, wobei die Gleitschalungsvorrichtung eine Plattform (12) mit einer Vielzahl von Arbeitsebenen (28, 30, 32) um einen Umfang davon herum, und die einen zentralen Raum (33) durch die Vielzahl von Arbeitsebenen (28, 30, 32) umgeben, und eine Hebevorrichtung zum Anheben oder Absenken der Plattform (12) beinhaltet, wobei die Hebevorrichtung eine oder mehrere Winden (16) oder Litzenheber beinhaltet, wobei jede Winde (16) oder jeder Litzenheber ein entsprechendes Seil (14) aufweist, wobei jede Winde (16) oder jeder Litzenheber durch ein Gitterrost-Gerüst (101) miteinander verbunden ist und wobei die Hebevorrichtung auf Bodenhöhe über der Plattform bereitgestellt ist und mindestens ein derartiges Seil mit der Plattform verbunden ist; wobei das Verfahren Folgendes umfasst:

Aufhängen der Plattform (12) von oben unter Verwendung der Hebevorrichtung;
Durchführen eines Bewehrungsvorgangs, der das Anheben der Plattform (12) unter Verwendung der Hebevorrichtung und das Installieren

mindestens eines Bewehrungskorbs (18, 20) beinhaltet;
Verwenden der Hebevorrichtung zum Absenken der Plattform (12) auf eine Basis des mindestens einen Bewehrungskorbs (18, 20); und
Durchführen eines Betongleitschalungsvorgangs des mindestens einen Bewehrungskorbs (18, 20), der das Anheben der Plattform (12) unter Verwendung der Hebevorrichtung beinhaltet.

5. Verfahren gemäß Anspruch 4, wobei der Bewehrungsinstallationsvorgang ferner das Verwenden einer der Vielzahl von Arbeitsebenen (28, 30, 32) zum Installieren von vertikalen Bewehrungsstäben und einer anderen der Vielzahl von Arbeitsebenen zum Installieren von horizontalen Bewehrungsstäben umfasst.

6. Verfahren gemäß Anspruch 4 oder 5, wobei der Betongleitschalungsvorgang ferner das Verwenden einer der Vielzahl von Arbeitsebenen (28, 30, 32) zum Gießen des Betons und einer anderen der Vielzahl von Arbeitsebenen (28, 30, 32) zum Endbearbeiten des abgebundenen Betons umfasst.

7. Verfahren gemäß einem der Ansprüche 4 bis 6 und ferner umfassend das Vorbereiten einer Schlitzwand des Schachts (10) unter Verwendung der Plattform (12) vor dem Durchführen des Bewehrungsinstallationsvorgangs, wobei das Vorbereiten der Schlitzwand das Installieren einer wasserdichten Barriere daran beinhaltet.

8. Verfahren gemäß einem der Ansprüche 4 bis 7, wobei das Verfahren ferner Folgendes umfasst:

Verbinden jedes jeweiligen Seils (14) zwischen der Plattform und einem oberen Ende des Schachts (10) und
Betätigen der einen oder mehreren Winden (16) oder des einen oder mehreren Litzenhebern, um die Plattform (12) anzuheben oder abzusenken.

9. Verfahren gemäß einem der Ansprüche 4 bis 8, wobei der Bewehrungsinstallationsvorgang ferner das Installieren von mehr als einem Bewehrungskorb (18, 20) umfasst, wobei ein nachfolgender Bewehrungskorb (18, 20) durch Absenken der Plattform (12) und anschließendes Anheben der Plattform (12) unter Verwendung der Hebevorrichtung und Installieren des nachfolgenden Bewehrungskorbs (18, 20) installiert wird.

10. Verfahren gemäß einem der Ansprüche 4 bis 9, wobei die Plattform (12) ferner einen Abschnitt (17) davon beinhaltet, der sich durch die Vielzahl von Arbeitsebenen (28, 30, 32) hindurch erstreckt, wobei das Verfahren ferner das Erbauen einer sekundären Gleitschalungsstruktur der primären Gleitschalungsstruktur unter Verwendung des Abschnitts (17) beinhaltet.

11. Verfahren gemäß Anspruch 10, wobei der Abschnitt (17) der Plattform eine Teilringform beinhaltet, wobei das Verfahren das Erbauen der sekundären Gleitschalungsstruktur aus Bewehrung als eine vertikale röhrenförmige Struktur unter Verwendung des teilringförmigen Abschnitts (17) umfasst, wobei die vertikale röhrenförmige Struktur innerhalb der primären Gleitschalungsstruktur befindlich ist,
und ferner umfassend das Erbauen der vertikalen röhrenförmigen Struktur während des Bewehrungsinstallationsvorgangs oder während des Betongleitschalungsvorgangs; und ferner umfassend das Durchführen des Betongleitschalungsvorgangs der vertikalen röhrenförmigen Struktur.

12. Verfahren gemäß Anspruch 10, wobei der Abschnitt (15) der Plattform mindestens einen Teil (15) davon beinhaltet, der eben ist, wobei das Verfahren das Erbauen einer flachen inneren vertikalen Fläche der primären Gleitschalungsstruktur unter Verwendung des ebenen Abschnitts (15) umfasst.

13. Verfahren gemäß einem der Ansprüche 10 bis 11 und ferner umfassend das Erbauen der sekundären Gleitschalungsstruktur, die einen Kanal oder Hohlraum in einer Seitenwand der primären Gleitschalungsstruktur beinhaltet.

14. Verfahren gemäß einem der Ansprüche 4 bis 13, wobei die Plattform (12) eine von ihr herabhängende Schalung (40, 41) auf einer oder beiden Seiten der primären Gleitschalungsstruktur, die eine innere Schalung (40) und eine äußere Schalung (41) umfasst, aufweist, wobei die innere Schalung (40) von einer ersten Arbeitsebene (28, 30, 32) herabhängt und die äußere Schalung (41) von einer zweiten Arbeitsebene (28, 30, 32) über eine Verkabelung herabhängt, wobei das Verfahren ferner das Verwenden der Schalung (40, 41) umfasst, um den gegossenen Beton auf einer oder beiden Seiten der primären Gleitschalungsstruktur aufzunehmen, bis er abgebunden hat.

Revendications

1. Un appareil de coffrage glissant destiné à construire une structure à coffrage glissant primaire à partir d'un côté de celui-ci, la structure étant un puits au-dessous du niveau du sol, l'appareil comprenant une plateforme (12) ayant une pluralité de niveaux de travail (28, 30, 32), et un dispositif de levage ayant au moins un câble (14), le dispositif de levage com-

prenant un ou plusieurs treuils (16) ou vérins à torons, chaque treuil (16) ou vérin à torons ayant un câble (14) respectif ; la plateforme étant apte à être suspendue depuis le dessus par ledit au moins un câble (14) et le dispositif de levage pouvant être mis en fonctionnement pour soulever ou abaisser la plateforme (12), où la pluralité de niveaux de travail (28, 30, 32) sont prévus autour d'un périmètre de la plateforme (12) et entourent un espace central (33) situé à travers la pluralité de niveaux de travail (28, 30, 32) ; **caractérisé en ce que** chaque treuil (16) ou vérin à torons est relié aux autres par une ossature en grillage (101), et où le dispositif de levage est prévu au niveau du sol au-dessus de la plateforme et au moins un dit câble est relié à la plateforme.

2. Un appareil de coffrage glissant selon la revendication précédente, où la plateforme (12) comprend en outre une portion (17, 15) de celle-ci destinée à construire une structure à coffrage glissant secondaire de la structure à coffrage glissant primaire, la portion s'étendant à travers la pluralité de niveaux de travail (28, 30, 32),

où la portion (17) de la plateforme (12) comprend une forme en anneau partiel qui est apte à former la structure à coffrage glissant secondaire comme une structure tubulaire verticale au sein de la structure à coffrage glissant primaire ; ou bien
où la portion (17) de la plateforme comprend au moins une partie de celle-ci qui est plane (15) et qui est apte à former une face verticale interne plate de la structure à coffrage glissant primaire ; et
où la portion (15) est apte à former la structure à coffrage glissant secondaire comprenant un conduit ou un vide dans une paroi latérale de la structure à coffrage glissant primaire.

3. Un appareil de coffrage glissant selon n'importe quelle revendication précédente, où la plateforme (12) a un coffrage (40) dépendant de celle-ci destiné à contenir du béton coulé de la structure à coffrage glissant primaire jusqu'à ce qu'il ait durci, ledit coffrage (40, 41) étant sur un côté ou sur les deux côtés de la structure à coffrage glissant primaire qui inclut un coffrage intérieur (40) et un coffrage extérieur (41), où le coffrage intérieur (40) dépend d'un premier niveau de travail (28, 30, 32), et le coffrage extérieur (41) dépend d'un deuxième niveau de travail (28, 30, 32) par l'intermédiaire d'un câblage.

4. Un procédé consistant à faire fonctionner un appareil de coffrage glissant pour construire une structure à coffrage glissant primaire dans un puits (10) au-dessous du niveau du sol à partir d'un côté de celui-ci, l'appareil de coffrage glissant comprenant une plateforme (12) ayant une pluralité de niveaux de travail (28, 30, 32) autour d'un périmètre de celle-ci et entourant un espace central (33) situé à travers la pluralité de niveaux de travail (28, 30, 32), et un dispositif de levage pour soulever ou abaisser la plateforme (12), le dispositif de levage comprenant un ou plusieurs treuils (16) ou vérins à torons, chaque treuil (16) ou vérin à torons ayant un câble (14) respectif, chaque treuil (16) ou vérin à torons étant relié aux autres par une ossature en grillage (101), et où le dispositif de levage est prévu au niveau du sol au-dessus de la plateforme et au moins un dit câble est relié à la plateforme ; le procédé incluant :

la suspension de la plateforme (12) depuis le dessus à l'aide du dispositif de levage ;
la réalisation d'une opération d'installation de barre d'armature comprenant le soulèvement de la plateforme (12) à l'aide du dispositif de levage et l'installation d'au moins une cage de barres d'armature (18, 20) ;
l'utilisation du dispositif de levage pour abaisser la plateforme (12) jusqu'à une base de l'au moins une cage de barres d'armature (18, 20) ; et
la réalisation d'une opération de coffrage glissant avec du béton de l'au moins une cage de barres d'armature (18, 20) comprenant le soulèvement de la plateforme (12) à l'aide du dispositif de levage.

5. Un procédé selon la revendication 4, où ladite opération d'installation de barre d'armature inclut en outre l'utilisation d'un niveau de la pluralité de niveaux de travail (28, 30, 32) pour installer des barres à béton armé verticales et d'un autre niveau de la pluralité de niveaux de travail pour installer des barres à béton armé horizontales.

6. Un procédé selon la revendication 4 ou la revendication 5, où ladite opération de coffrage glissant avec du béton inclut en outre l'utilisation d'un niveau de la pluralité de niveaux de travail (28, 30, 32) pour le coulage du béton et d'un autre niveau de la pluralité de niveaux de travail (28, 30, 32) pour effectuer la finition du béton durci.

7. Un procédé selon n'importe lesquelles des revendications 4 à 6, et incluant en outre la préparation d'une paroi moulée du puits (10) à l'aide de la plateforme (12) préalablement à la réalisation de ladite opération d'installation de barre d'armature, où ladite préparation de la paroi moulée comprend l'installation d'une barrière hydrofuge sur celle-ci.

8. Un procédé selon n'importe lesquelles des revendications 4 à 7, où le procédé inclut en outre :

la liaison de chaque câble (14) respectif entre la plateforme et un dessus du puits (10), et
la mise en fonctionnement des un ou plusieurs treuils (16) ou vérins à torons pour soulever ou abaisser la plateforme (12).

9. Un procédé selon n'importe lesquelles des revendications 4 à 8, où ladite opération d'installation de barre d'armature inclut en outre l'installation de plus d'une cage de barres d'armature (18, 20), où une cage de barres d'armature (18, 20) subséquente est installée en abaissant la plateforme (12) et ensuite en soulevant la plateforme (12) à l'aide du dispositif de levage et en installant la cage de barres d'armature (18, 20) subséquente.

10. Un procédé selon n'importe lesquelles des revendications 4 à 9, où la plateforme (12) comprend en outre une portion (17) de celle-ci s'étendant à travers la pluralité de niveaux de travail (28, 30, 32), le procédé incluant en outre la construction d'une structure à coffrage glissant secondaire de la structure à coffrage glissant primaire à l'aide de la portion (17).

11. Un procédé selon la revendication 10, où la portion (17) de la plateforme comprend une forme en anneau partiel, le procédé incluant la construction de la structure à coffrage glissant secondaire à partir de barres d'armature comme une structure tubulaire verticale à l'aide de la portion (17) de forme en anneau partiel, ladite structure tubulaire verticale étant située au sein de la structure à coffrage glissant primaire,

et incluant en outre la construction de la structure tubulaire verticale durant ladite opération d'installation de barre d'armature ou durant ladite opération de coffrage glissant avec du béton ;
et incluant en outre la réalisation de ladite opération de coffrage glissant avec du béton de la structure tubulaire verticale.

12. Un procédé selon la revendication 10, où la portion (15) de la plateforme comprend au moins une partie (15) de celle-ci qui est plane, le procédé incluant la construction d'une face verticale interne plate de la structure à coffrage glissant primaire à l'aide de la portion (15) plane.

13. Un procédé selon n'importe lesquelles des revendications 10 à 11, et incluant en outre la construction de la structure à coffrage glissant secondaire comprenant un conduit ou un vide dans une paroi latérale de la structure à coffrage glissant primaire.

14. Un procédé selon n'importe lesquelles des revendications 4 à 13, où la plateforme (12) a un coffrage (40, 41) dépendant de celle-ci sur un côté ou sur les deux côtés de la structure à coffrage glissant primaire qui inclut un coffrage intérieur (40) et un coffrage extérieur (41), où le coffrage intérieur (40) dépend d'un premier niveau de travail (28, 30, 32), et le coffrage extérieur (41) dépend d'un deuxième niveau de travail (28, 30, 32) par l'intermédiaire d'un câblage, le procédé incluant en outre l'utilisation dudit coffrage (40, 41) pour contenir le béton coulé sur un côté ou sur les deux côtés de la structure à coffrage glissant primaire jusqu'à ce qu'il ait durci.

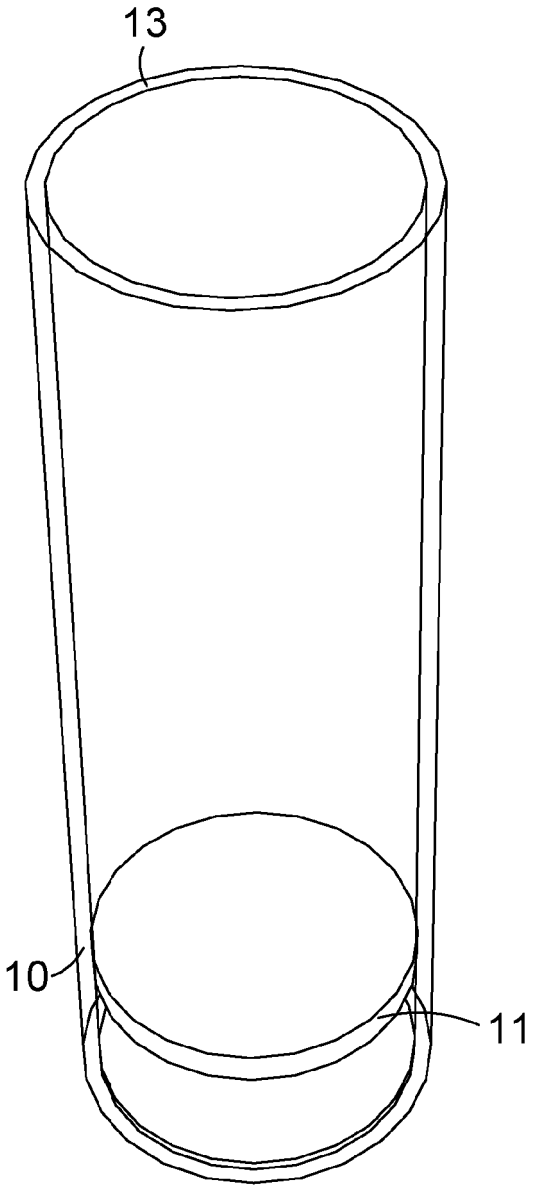


FIG. 1

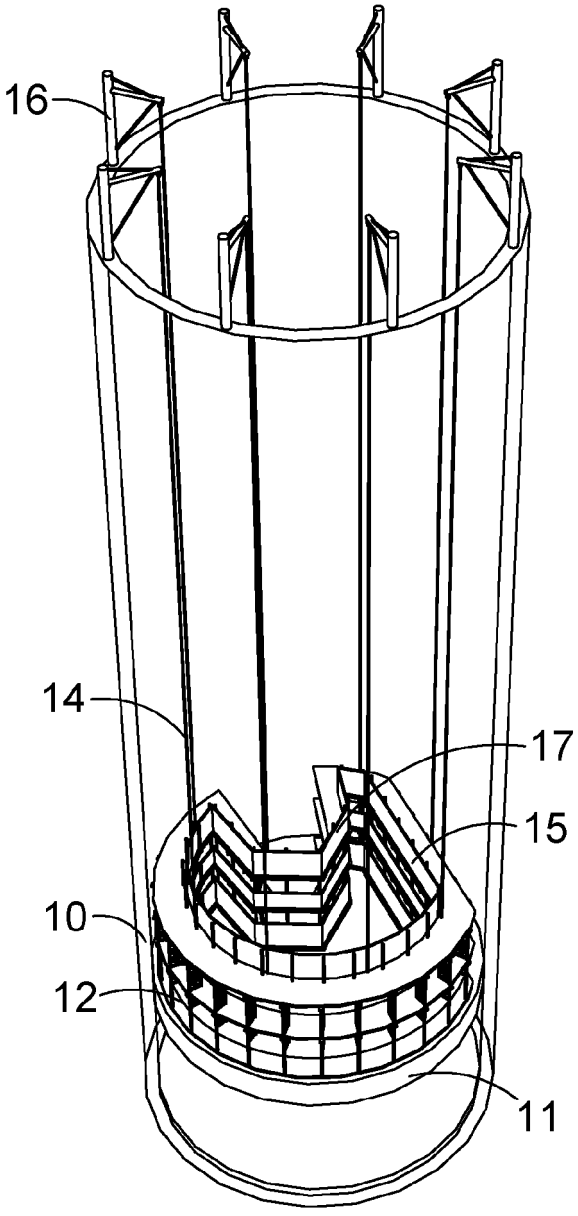


FIG. 2

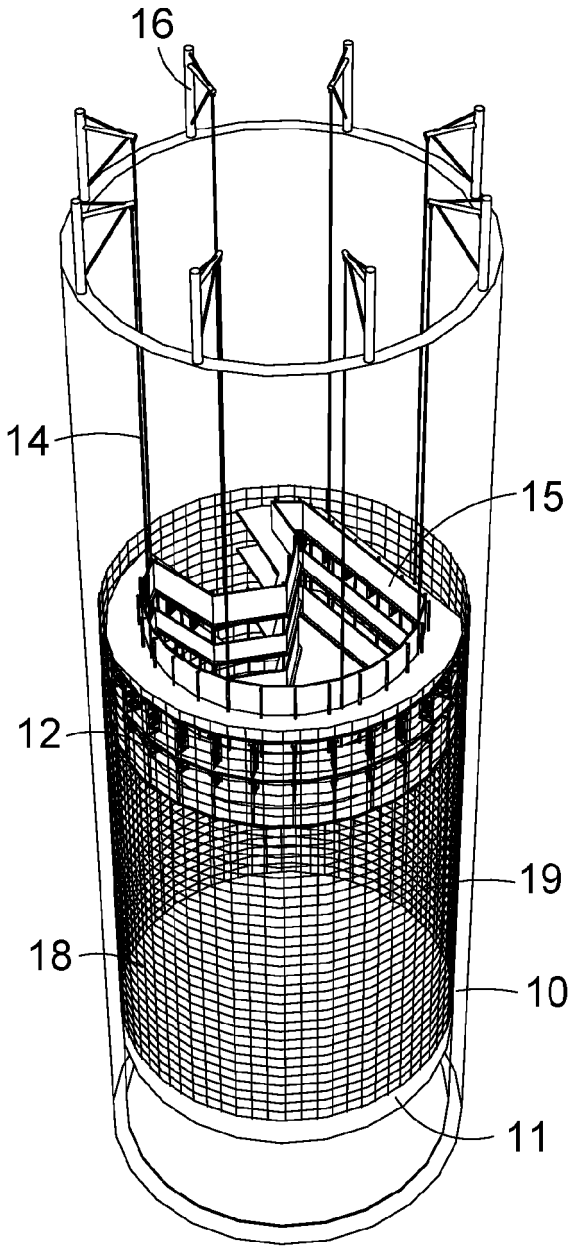


FIG. 3

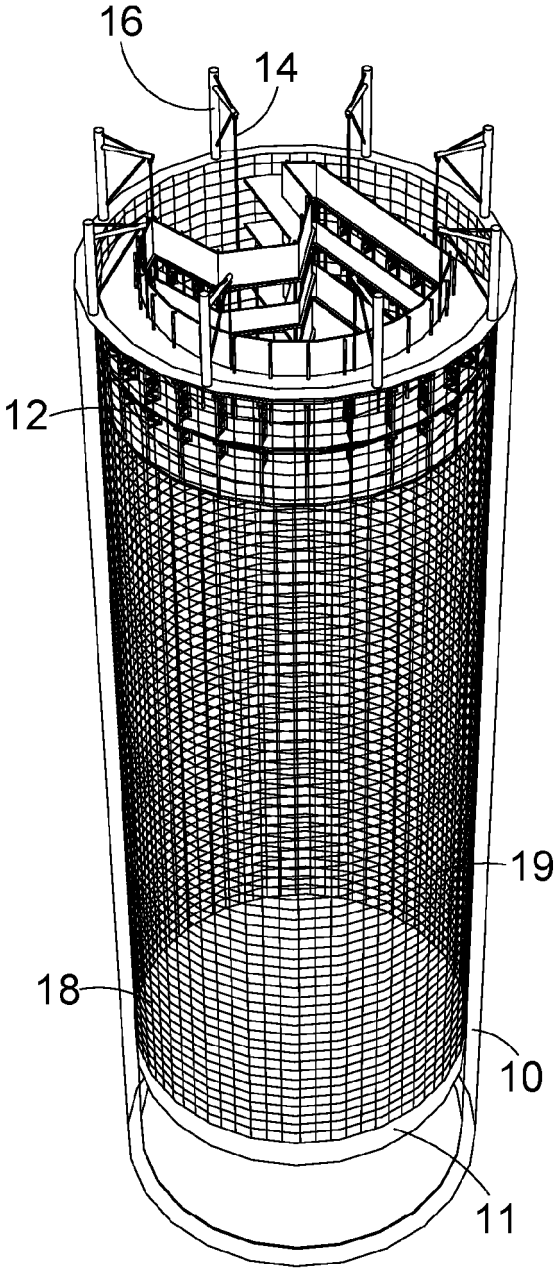


FIG. 4

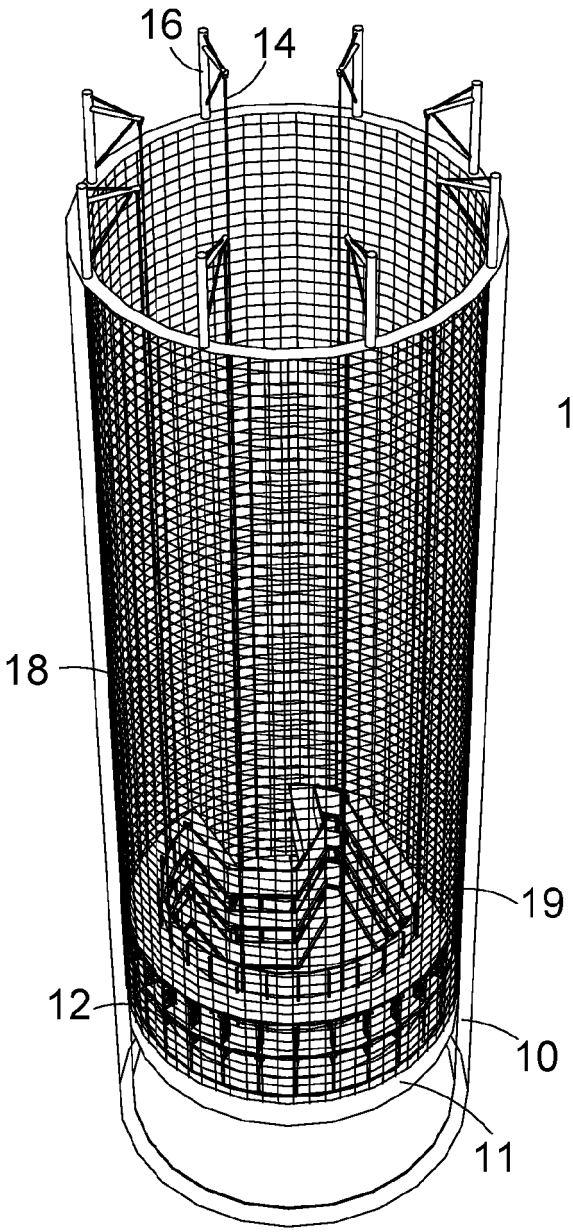


FIG. 5

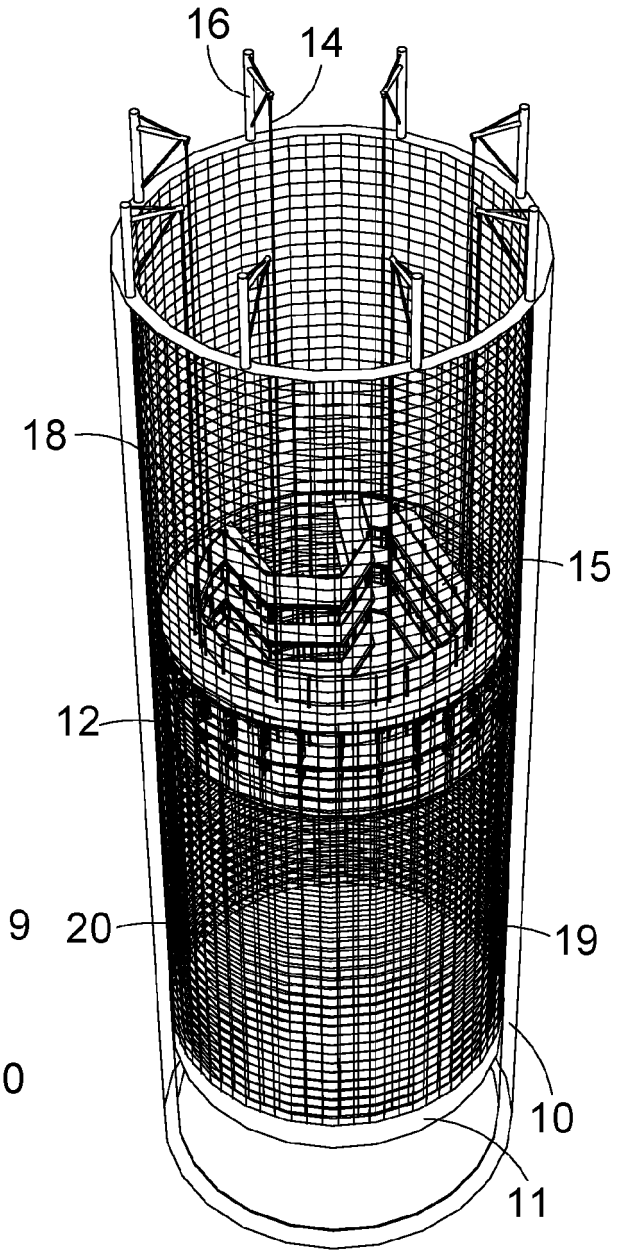


FIG. 6

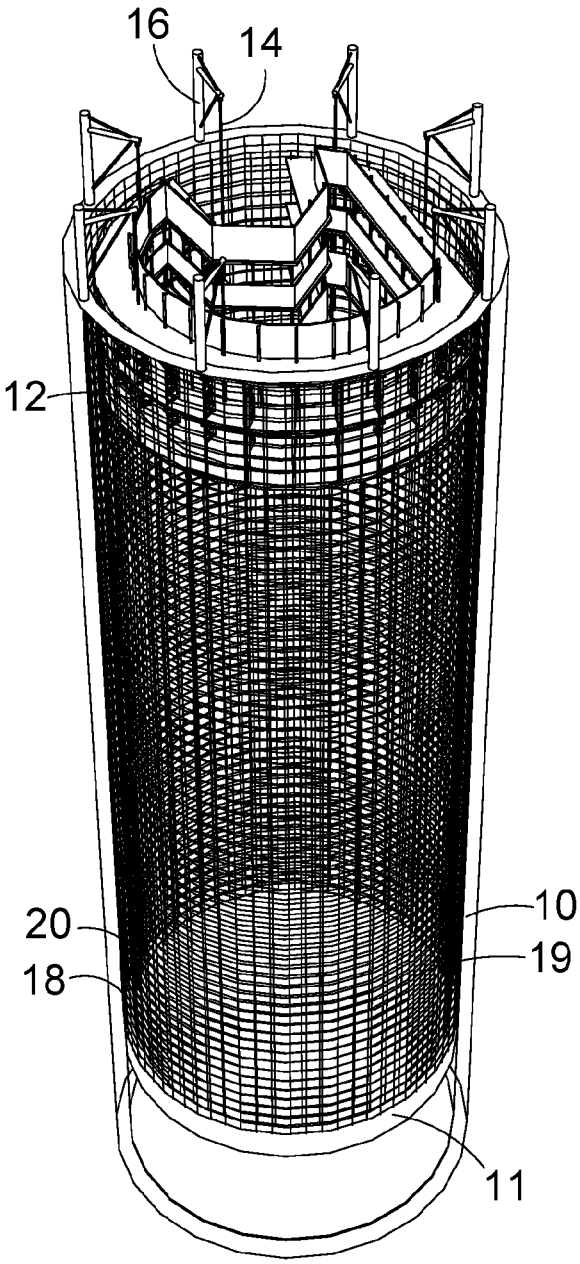


FIG. 7

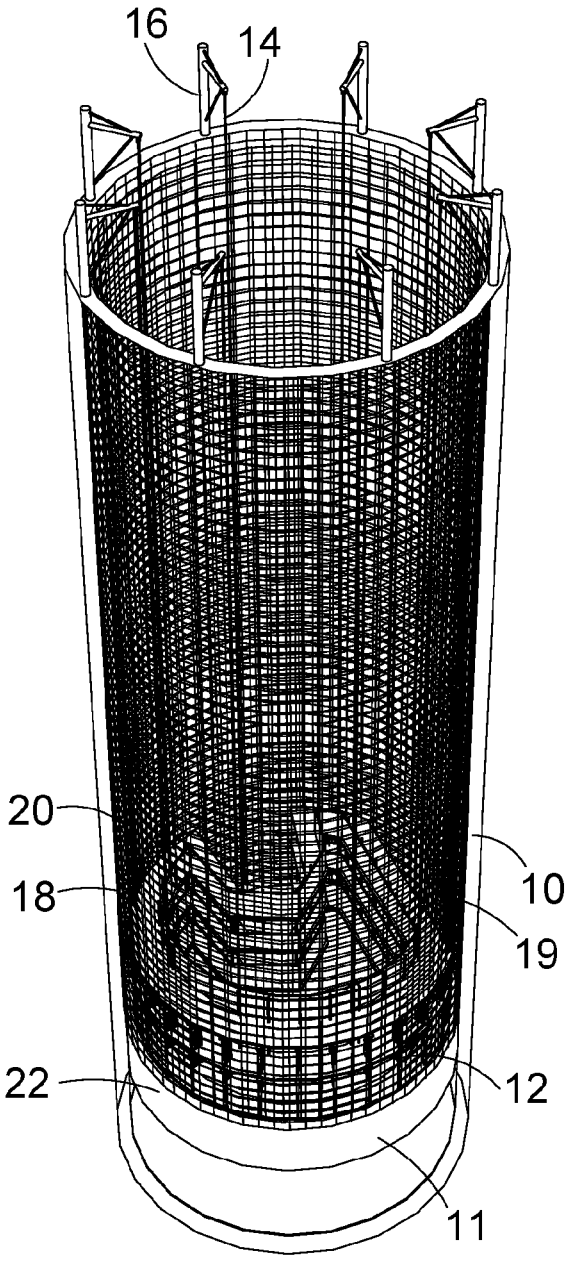


FIG. 8

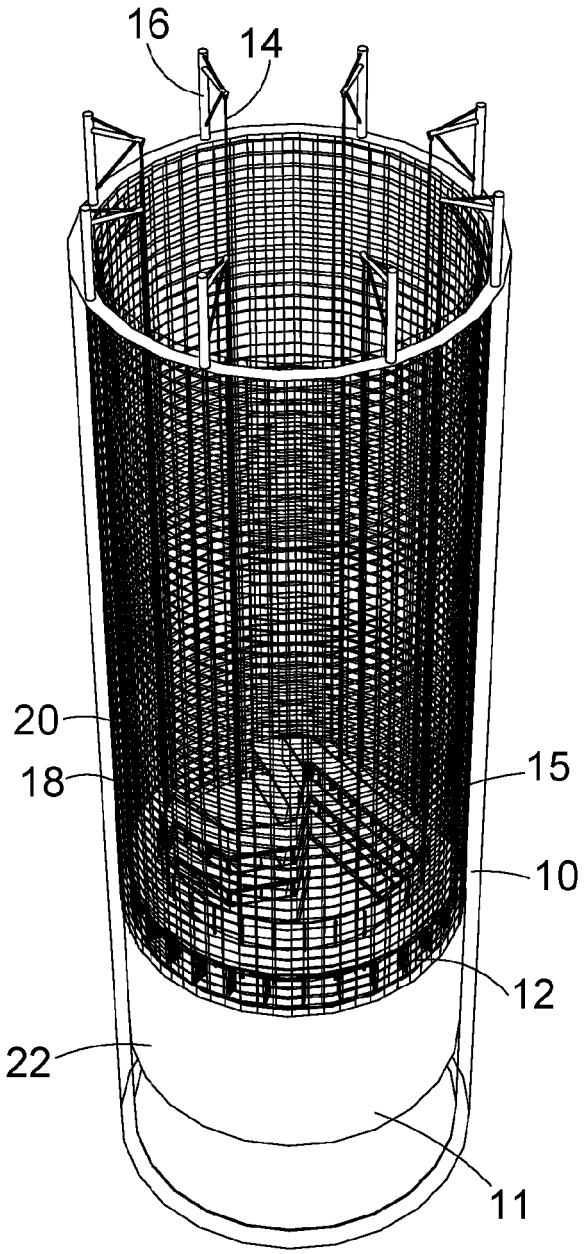


FIG. 9

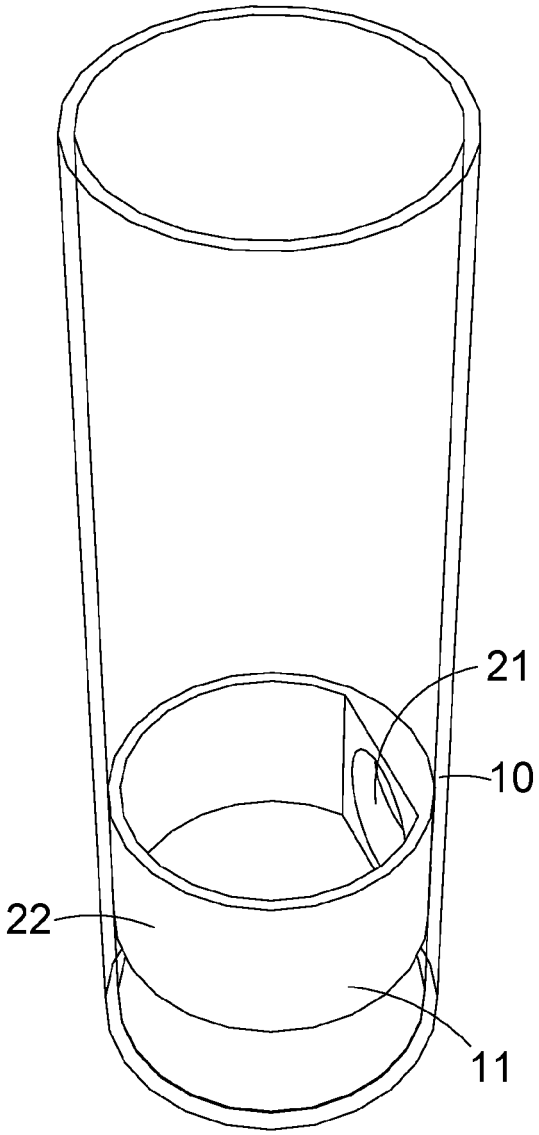


FIG. 10

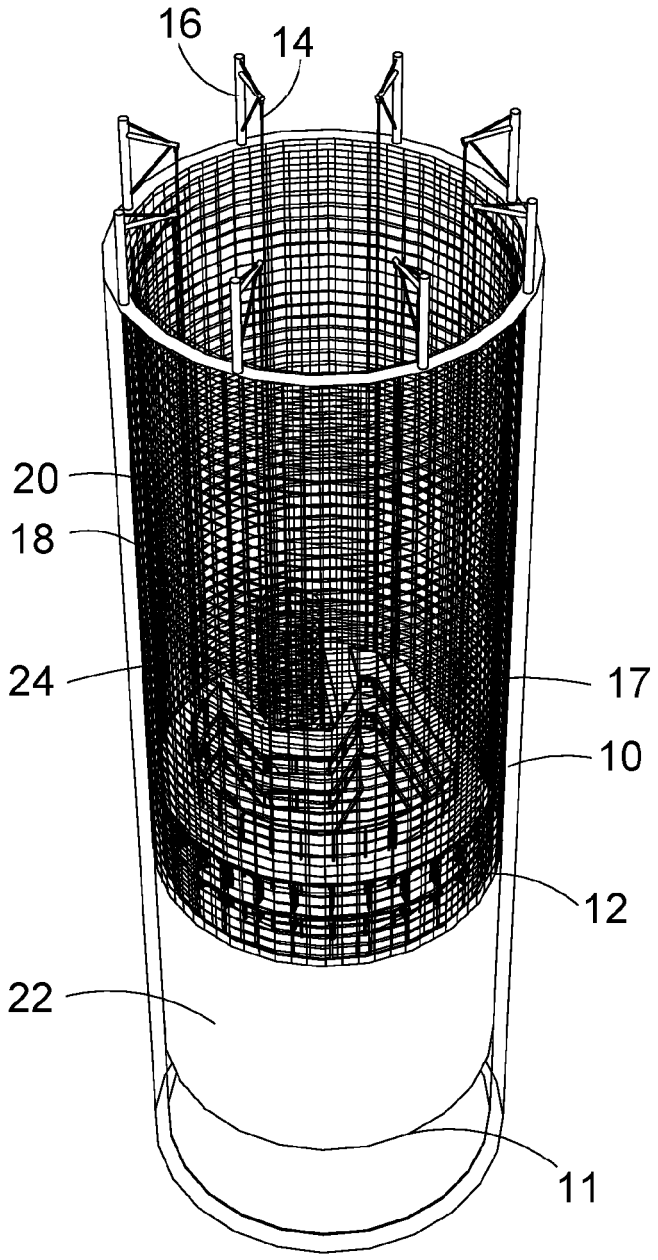


FIG. 11

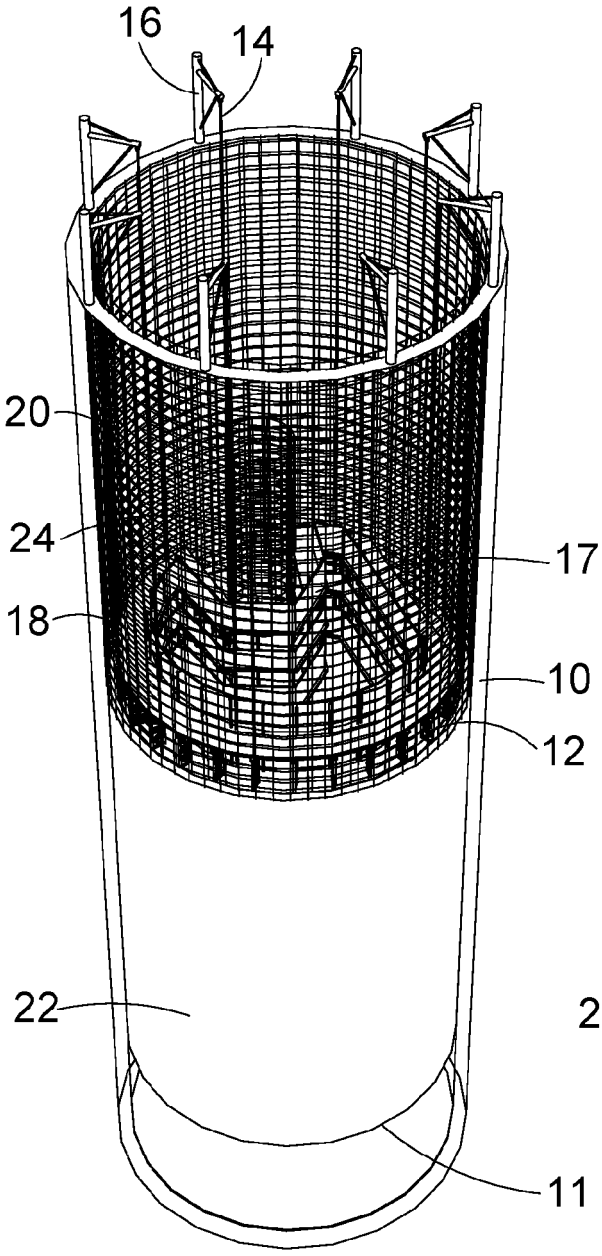


FIG. 12

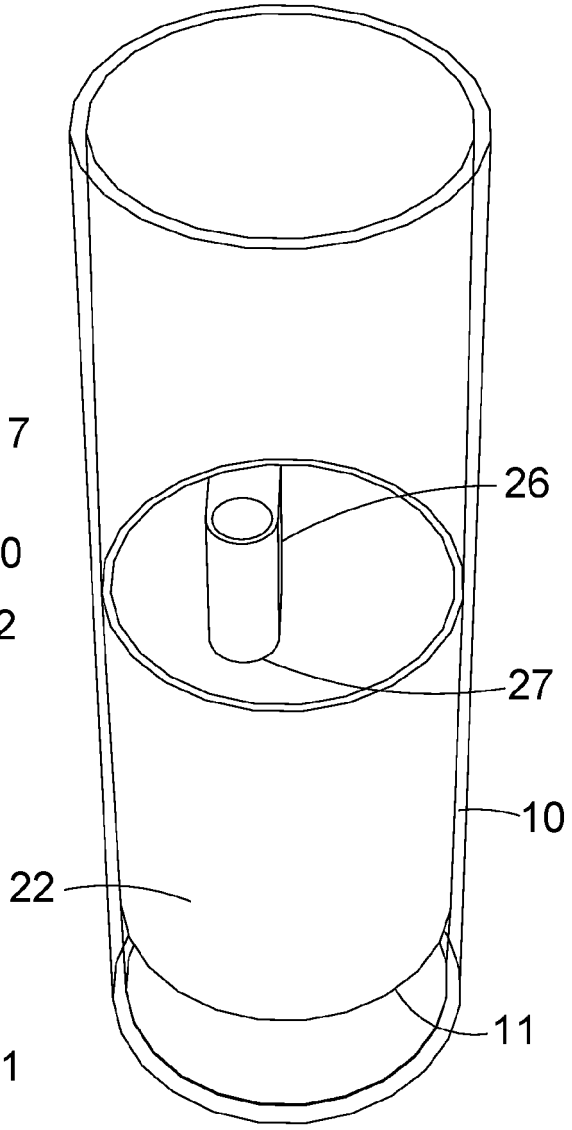


FIG. 13

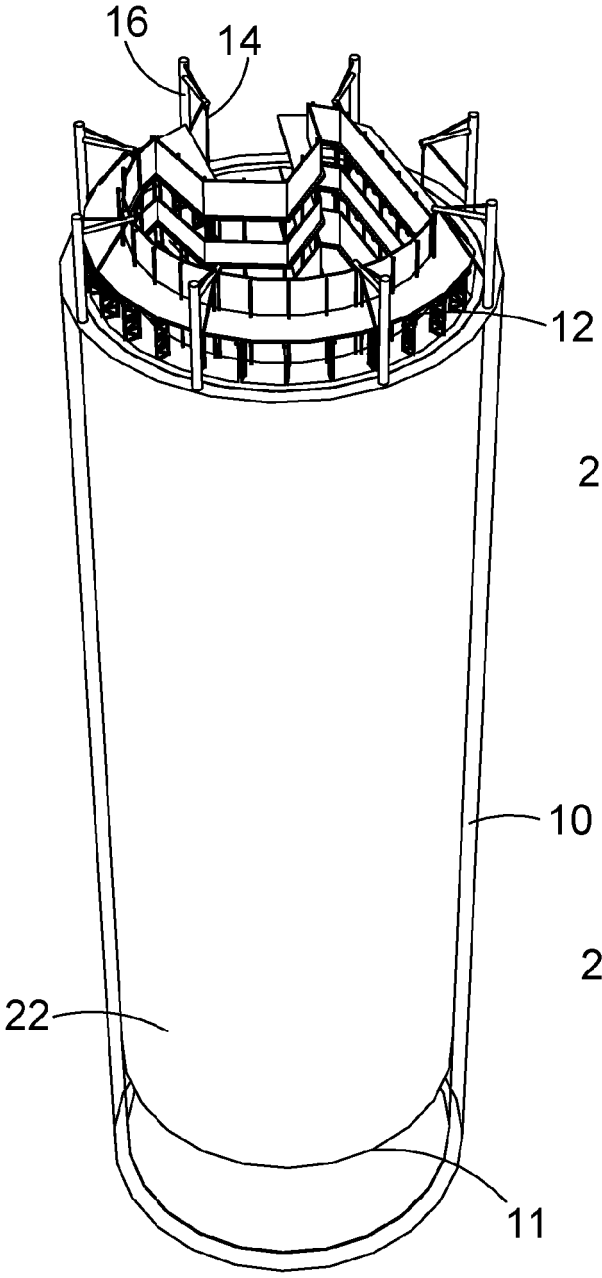


FIG. 14

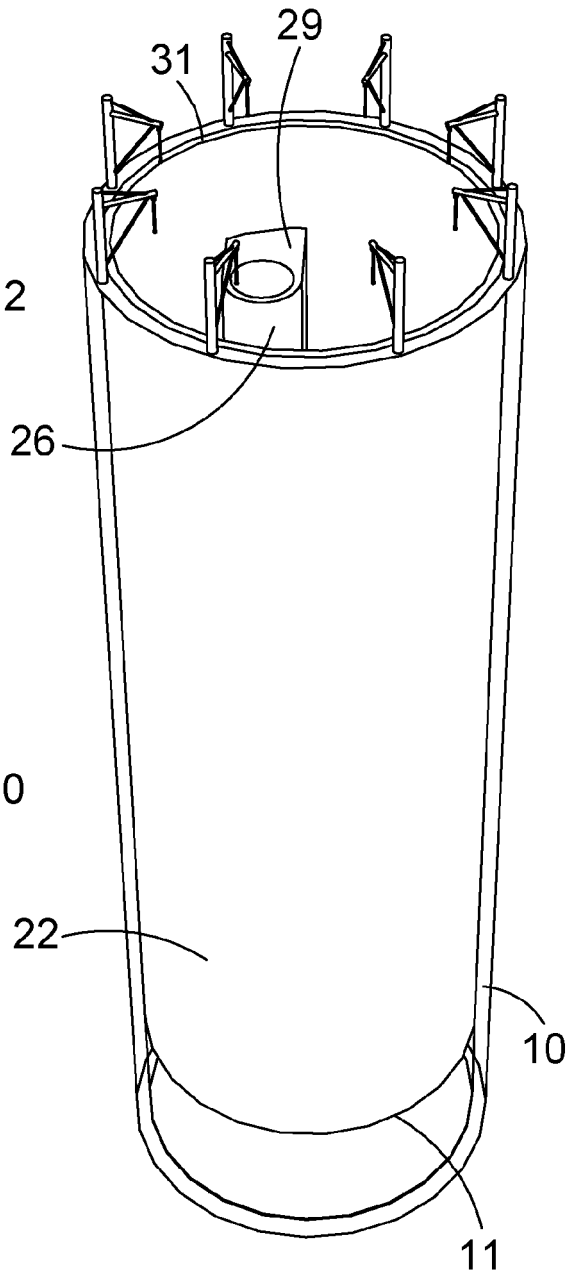


FIG. 15

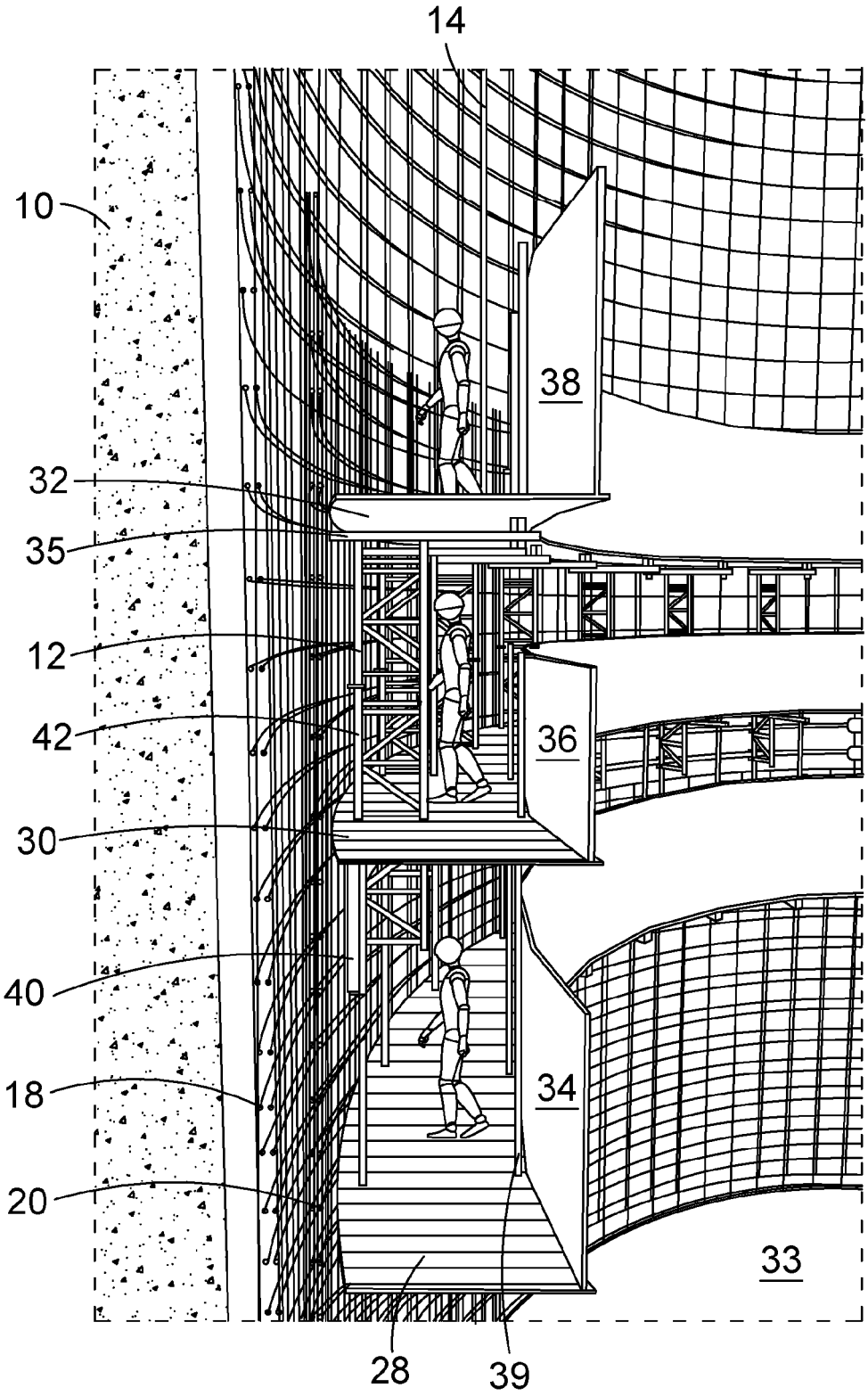
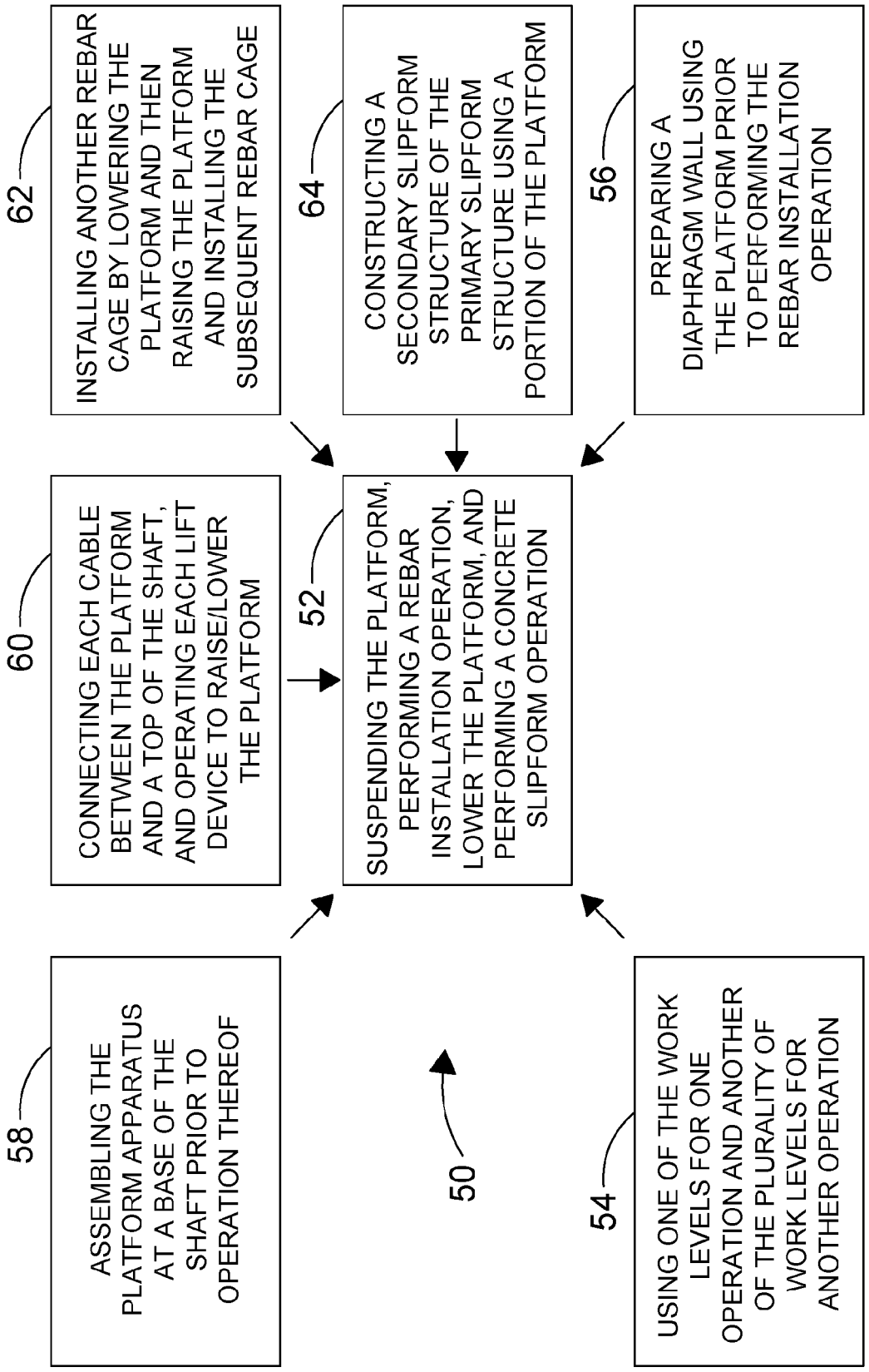


FIG. 16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SUSPENDING THE PLATFORM, PERFORMING A REBAR INSTALLATION OPERATION, LOWER THE PLATFORM, AND PERFORMING A CONCRETE SLIPFORM OPERATION
USING ONE OF THE WORK LEVELS FOR ONE OPERATION AND ANOTHER OF THE PLURALITY OF WORK LEVELS FOR ANOTHER OPERATION
PREPARING A DIAPHRAGM WALL USING THE PLATFORM PRIOR TO PERFORMING THE REBAR INSTALLATION OPERATION
CONSTRUCTING A SECONDARY SLIPFORM STRUCTURE OF THE PRIMARY SLIPFORM STRUCTURE USING A PORTION OF THE PLATFORM
ASSEMBLING THE PLATFORM APPARATUS AT A BASE OF THE SHAFT PRIOR TO OPERATION THEREOF
CONNECTING EACH CABLE BETWEEN THE PLATFORM AND A TOP OF THE SHAFT, AND OPERATING EACH LIFT DEVICE TO RAISE/LOWER THE PLATFORM
INSTALLING ANOTHER REBAR CAGE BY LOWERING THE PLATFORM AND THEN RAISING THE PLATFORM AND INSTALLING THE SUBSEQUENT REBAR CAGE

FIG. 17

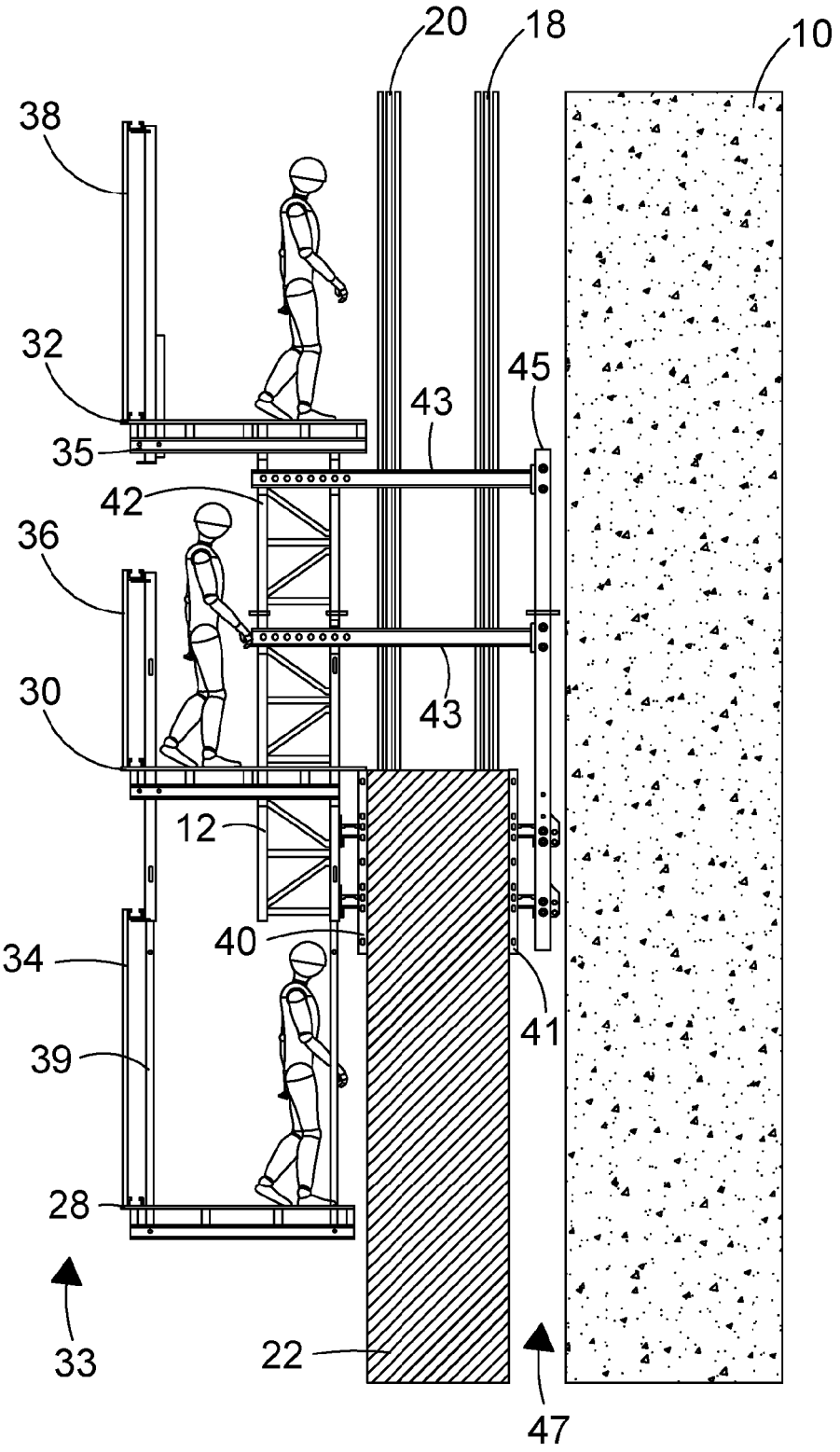

FIG. 18

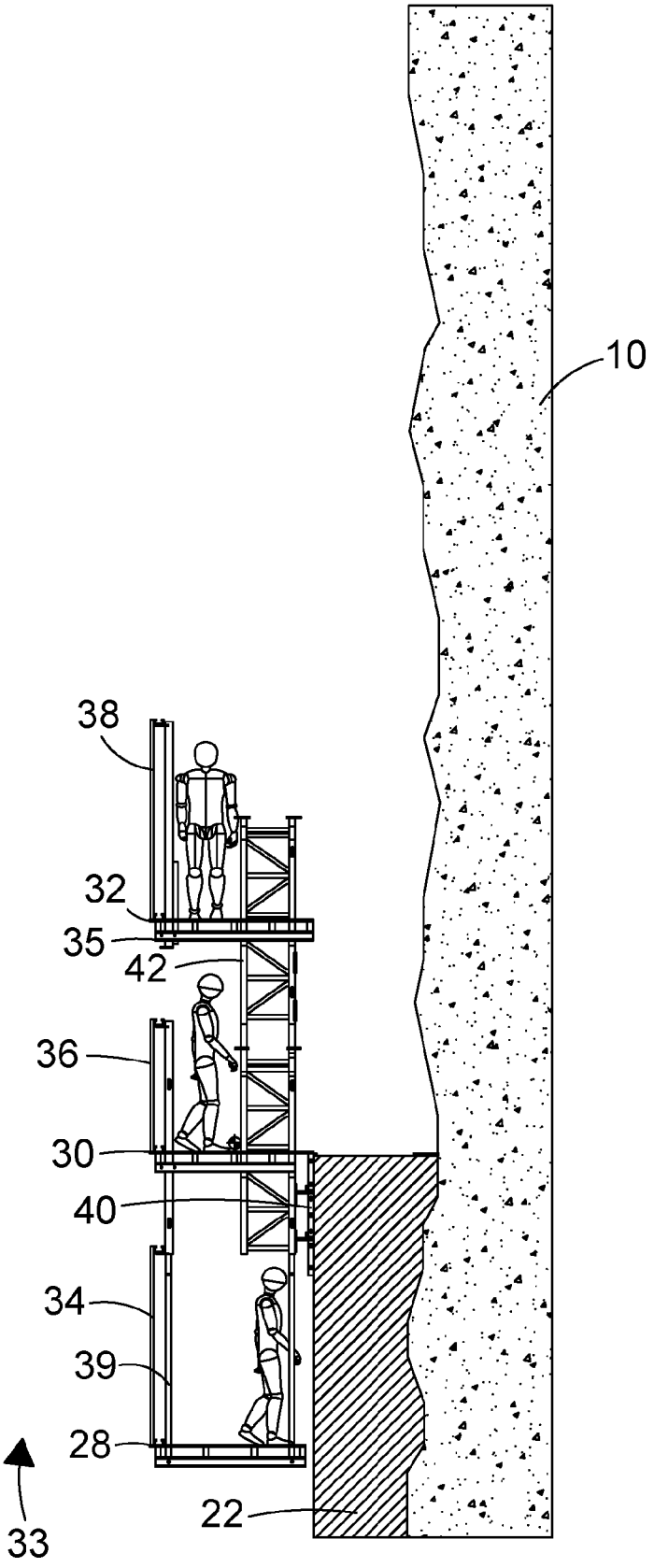

FIG. 19

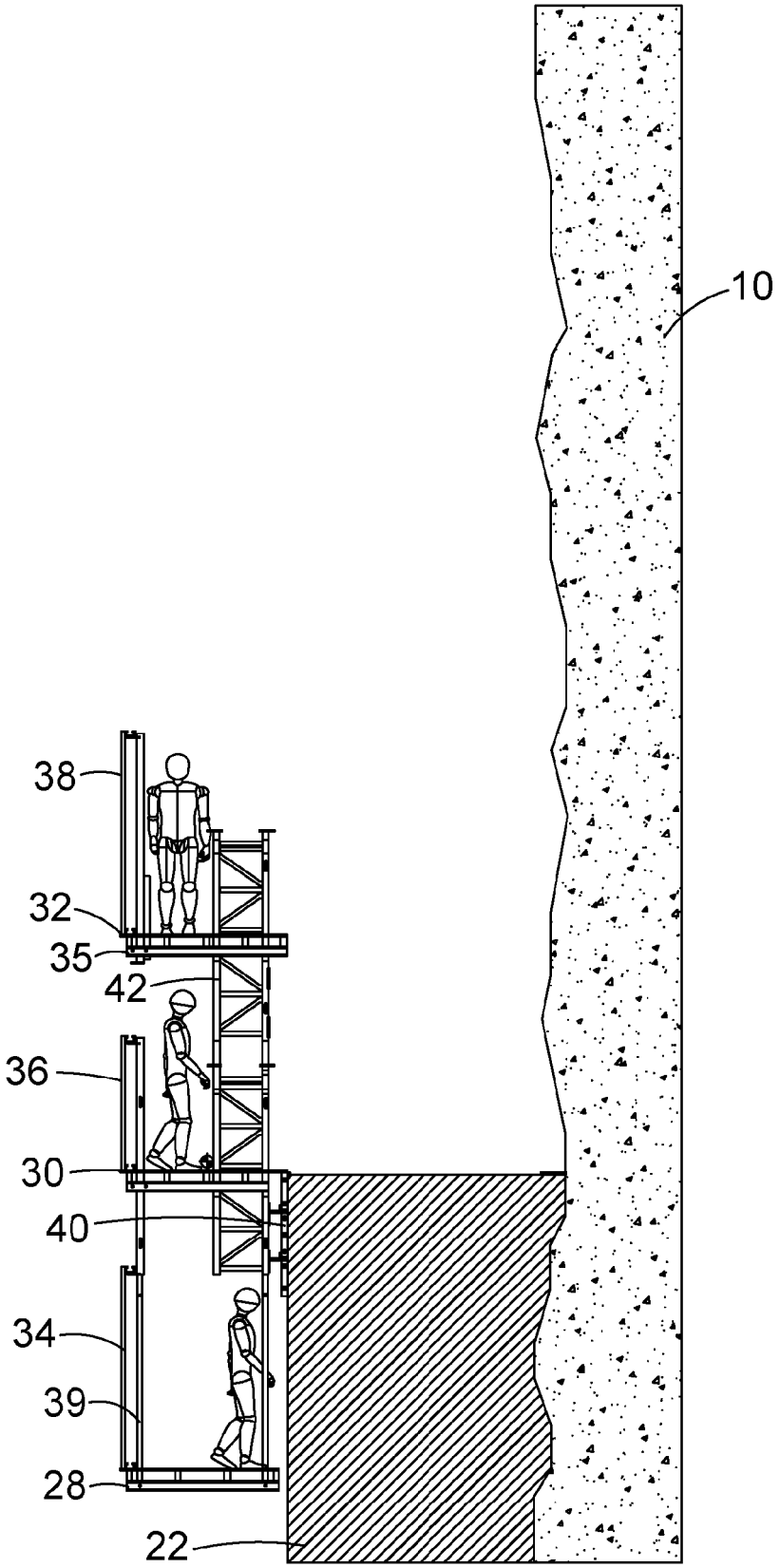

FIG. 20

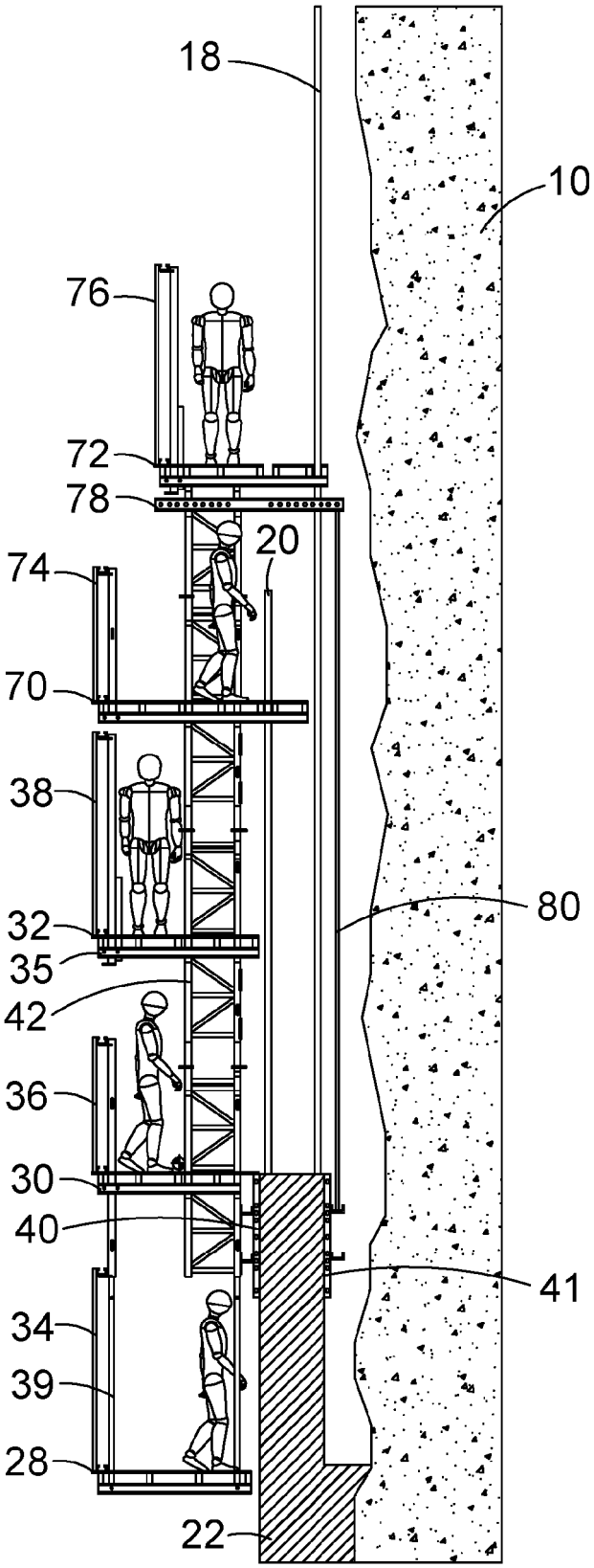

FIG. 21

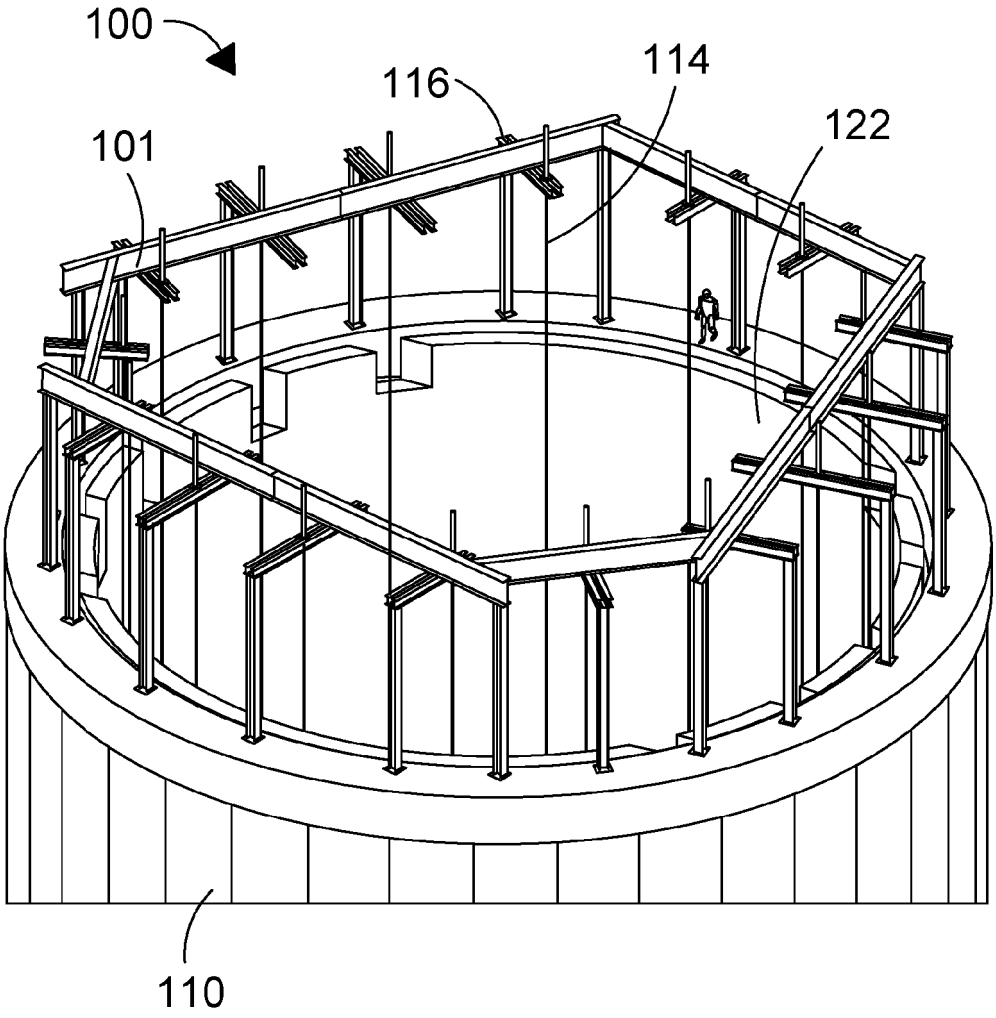

FIG. 22

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- KR 101218185 **[0004] [0005]**
- NL 86570 C **[0006]**