

(12) STANDARD PATENT
(19) AUSTRALIAN PATENT OFFICE

(11) Application No. **AU 2020257049 B2**

(54) Title
CONSTRUCTION METHOD FOR FORMING WATER-PROOF GROUTING CURTAIN IN WATER-RICH POROUS ROCK STRATUM BY BLASTING

(51) International Patent Classification(s)
E21C 41/16 (2006.01) **E21F 16/00** (2006.01)
E02D 19/16 (2006.01) **F42D 3/04** (2006.01)

(21) Application No: **2020257049** (22) Date of Filing: **2020.10.20**

(30) Priority Data

(31)	Number	(32)	Date	(33)	Country
	202010743733.X		2020.07.29		CN

(43) Publication Date: **2022.02.17**

(43) Publication Journal Date: **2022.02.17**

(44) Accepted Journal Date: **2022.06.02**

(71) Applicant(s)
China University of Mining and Technology

(72) Inventor(s)
REN, Yanlong; YANG, Weihao; LI, Haipeng; HUANG, Jiahui; YANG, Zhijiang

(74) Agent / Attorney
Lord & Company, PO Box 530, West Perth, WA, 6872, AU

(56) Related Art
CN 108005653 A
CN 104453913 B
US 5634691 A
US 3688507 A
US 3690106 A
US 3971318 A
WO 2019/014716 A1

ABSTRACT

A construction method for forming a water-proof grouting curtain in a water-rich porous rock stratum by blasting, comprising: constructing a plurality of blasting boreholes on the periphery of a shaft until it reaches an impermeable stratum, and drilling a pumping inspection hole in the center of the shaft until it reaches the impermeable stratum; lowering seamless steel pipes into the blasting boreholes; sequentially lowering plastic pipes loaded with water-resistant explosives and detonators in the blasting boreholes; detonating the explosives through detonating tubes, and pulling the water-rich porous rock stratum between the boreholes apart through blasting to form a circle of penetrating grouting cracks, or crushing the rock stratum to form a good permeability channel for grouting fluid; perforating and grouting the blasted boreholes; before and after grouting, carrying out a pumping test to check the change in water inflow of the shaft; and when a complete grouting water-proof curtain is formed, excavating the shaft. The present invention forms penetrating cracks or good permeability channels for grouting fluid by drilling and blasting, and forms a water-proof curtain through grouting to cut off the channel through which water in the porous rock stratum seeps into the shaft, so as to achieve the purpose of shaft construction in the absence of or in the presence of small amounts of water.

DRAWINGS

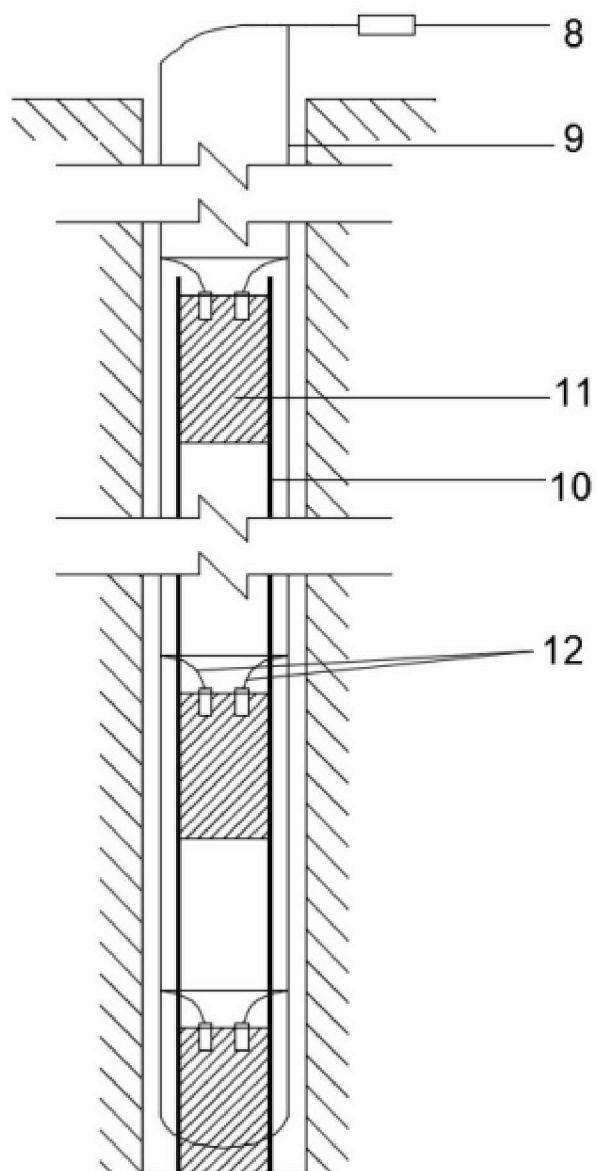


FIG. 3

DESCRIPTION

CONSTRUCTION METHOD FOR FORMING WATER-PROOF GROUTING CURTAIN IN WATER-RICH POROUS ROCK STRATUM BY BLASTING

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to the field of mine engineering construction technologies, and in particular, to a construction method for forming a water-proof grouting curtain in a water-rich porous rock stratum by blasting.

Description of Related Art

In many areas, mineral resources are buried in deep strata that pass through water-rich rock strata. These rock strata are mostly Cretaceous, Jurassic and other rock strata, with many aquifers and stratum water mostly existing in the form of pore water. When the rock fissures are relatively developed and the water inflow of the fissures is high, the grouting method is generally used to plug the fissure water, and then the ordinary shaft sinking construction method is used to construct the shaft. However, when the stratum water exists in the form of pore water, a large number of engineering examples prove that the use of ground pre-grouting or working face pre-grouting to plug water often cannot make the shaft pass through the water-rich rock stratum successfully. Therefore, at present, under such stratum conditions, a large number of shafts are constructed by using a freezing method. The specific approach is: first freezing the stratum around the shaft to be constructed by an artificial freezing method to form a frozen wall, which temporarily isolates underground water from the inside of the shaft; and excavating the shaft and pouring the frozen shaft wall under the protection of the frozen wall. After the shaft is formed, the frozen wall melts under the action of ground temperature, and the shaft wall bears the rock and soil pressure and water pressure from the stratum. The freezing method is adopted to construct the shaft, and the shaft wall is generally a double-layer concrete composite shaft wall. As the depth of the shaft increases, the thickness of the shaft wall is too large, the project cost is extremely high, the construction period becomes longer, and the construction process is complicated. Therefore, how to form an effective water-proof curtain under such stratum

DESCRIPTION

conditions to reduce or even eliminate the water pressure acting on the shaft wall, thereby reducing the thickness of the shaft wall and reducing the water leakage of the shaft has become an urgent problem to be solved in the construction of the vertical shaft.

SUMMARY OF THE INVENTION

Technical Problem

An objective of the present invention is to provide a construction method for forming a water-proof grouting curtain in a water-rich porous rock stratum by blasting.

Technical Solution

To achieve the foregoing objective, the present invention adopts the following technical solution: a construction method for forming a water-proof grouting curtain in a water-rich porous rock stratum by blasting, comprising the following steps:

step 1: constructing a plurality of blasting boreholes on the periphery of a shaft to be constructed, and vertically drilling downwards from the ground with a drilling rig until it penetrates through the water-rich porous rock stratum and reaches an impermeable stratum; and drilling a pumping inspection hole near the center of the shaft to be constructed, and vertically drilling downwards from the ground with the drilling rig until it penetrates through the water-rich porous rock stratum and reaches the impermeable stratum;

step 2: lowering seamless steel pipes with openings at the bottom into the constructed blasting boreholes respectively, wherein the seamless steel pipes have the length passing through a topsoil or alluvium and entering a stable rock stratum by a certain depth, and performing fixing the seamless steel pipes after the seamless steel pipes are lowered in place;

step 3: lowering plastic pipes loaded with water-resistant explosives and detonators in the blasting boreholes around the shaft to be constructed, sealing the orifices of the plastic pipes with stemming after charging, laying detonating tubes over the entire length of the plastic pipes and taking measures to protect the detonating tubes from damage in the lowering process, and connecting the detonating tubes to an initiator;

step 4: detonating the explosives after the preparatory work is finished, and pulling the water-rich porous rock stratum between the boreholes apart through one or more blasts to form

DESCRIPTION

a circle of penetrating grouting cracks, or crushing the rock stratum to form a good permeability channel for grouting fluid, wherein the blasting scheme involves blasting once or multiple times according to the entire height or segmentation height of the water-rich porous rock stratum;

step 5: perforating the blasted boreholes to the depth of the borehole bottom, and then grouting the perforated borehole; before grouting, inspecting the groutability of the grouting fluid in the water-rich porous rock stratum between the boreholes through a drilling peeping instrument; if it is inspected that the groutability is poor, blasting again until the requirements are met; and before and after grouting, carrying out a pumping test through the pumping inspection hole in the center of the shaft to check the change in water inflow of the shaft; and

step 6: when the water pumping of the pumping inspection hole shows that a complete grouting water-proof curtain has been formed, excavating the shaft according to the designed shaft parameters.

Preferably, at least a circle of the blasting boreholes is uniformly arranged at intervals from inside to outside on the periphery of the shaft with the center of the shaft as the circle center.

More preferably, the spacing between adjacent blasting boreholes is 1-2 m.

More preferably, the interval between two adjacent circles of blasting boreholes is 1-3 m.

Preferably, in order to enhance the blasting effect, grooves not greater than 10 cm can be formed on both sides of each blasting borehole by high-pressure water jet or other methods respectively to form cracks between the boreholes.

Preferably, in step 2, the joint between the seamless steel pipes is the end-to-end butt welding connection of the seamless steel pipes through outer collars.

Preferably, in step 3, grooves are symmetrically formed on the sidewalls of the plastic pipes for energy gathering in blasting.

Preferably, in step 3, the water-resistant explosives are water-gel explosives.

Preferably, in step 4, the explosive detonation mode is simultaneous detonation or millisecond delay detonation.

Preferably, in step 5, the grouting material is a cement-based grouting material or a chemical grouting material.

DESCRIPTION

Advantageous Effect

Compared with the prior art, the present invention has the following beneficial effects.

1. The present invention forms penetrating cracks or good permeability channels for grouting fluid around the shaft that is meant to penetrate the water-rich porous rock stratum by drilling and blasting, and forms a reliable grouting water-proof curtain through grouting to cut off the channel through which water in the porous rock stratum seeps into the shaft, so as to achieve the purpose of shaft construction in the absence of or in the presence of small amounts of water.

2. Since the formed grouting curtain cuts off the seepage channel of water, the external load on the shaft wall no longer contains the water pressure, and there is no need to spend a huge cost to use the freezing method for construction, which is economical.

3. Due to the reduction of the external load on the shaft wall, the design method and concept of the shaft wall have changed accordingly. The thickness of the shaft wall is greatly reduced, the project cost is greatly lowered, and the construction period is greatly shortened, which has very important engineering practical value and significance.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic diagram of a construction method for forming a water-proof grouting curtain in a water-rich porous rock stratum by blasting according to Embodiment 1 of the present invention;

FIG. 2 is a schematic diagram of the layout of blasting boreholes according to Embodiment 1 of the present invention;

FIG. 3 is a schematic diagram of explosive charging in the blasting boreholes according to Embodiment 1 of the present invention;

FIG. 4 is a schematic diagram of a construction method for forming a water-proof grouting curtain in a water-rich porous rock stratum by blasting according to Embodiment 2 of the present invention;

FIG. 5 is a schematic diagram of the layout of blasting boreholes according to Embodiment 2 of the present invention; and

DESCRIPTION

FIG. 6 is a schematic diagram of the layout of blasting boreholes according to Embodiment 3 of the present invention.

In the drawings, 1-shaft, 2-blasting borehole, 3-pumping inspection hole, 4-topsoil or alluvium, 5-water-rich porous rock stratum, 6-impermeable stratum, 8-initiator, 9-detonating tube, 10-plastic pipe, 11-cartridge, 12-detonator.

DETAILED DESCRIPTION OF THE INVENTION

The present invention is further described below in detail with reference to the accompanying drawings and specific embodiments.

Embodiment 1

As shown in FIG. 1, a construction method for forming a water-proof grouting curtain in a water-rich porous rock stratum by blasting, comprising the following steps:

step 1: as shown in FIG. 2, constructing a circle of blasting boreholes 2 on the periphery of a shaft 1 to be constructed with the center of the shaft 1 as the circle center, wherein the spacing between adjacent blasting boreholes 2 is 1.2 m, and vertically drilling downwards from the ground with a drilling rig until it penetrates through the water-rich porous rock stratum 5 and reaches an impermeable stratum 6; respectively forming grooves with a depth of not greater than 10 cm on both sides of each blasting borehole 2 through high-pressure water jets, wherein the grooves can form cracks between the blasting boreholes 2; and drilling a pumping inspection hole 3 near the center of the shaft to be constructed, and vertically drilling downwards from the ground with the drilling rig until it penetrates through the water-rich porous rock stratum 5 and reaches the impermeable stratum 6;

step 2: lowering seamless steel pipes with openings at the bottom into the constructed blasting boreholes 2 respectively, wherein the depth to which the seamless steel pipes are lowered is determined based on the principle of ensuring that the drilling does not collapse, and in general, the seamless steel pipes have the length passing through a topsoil or alluvium 4 and entering a stable rock stratum by a certain depth; and performing fixing the seamless steel pipes after the seamless steel pipes are lowered in place, the joint between the seamless steel pipes being the end-to-end butt welding connection of the seamless steel pipes through outer collars;

DESCRIPTION

step 3: as shown in FIG. 3, sequentially lowering plastic pipes 10 loaded with water-gel explosive cartridges 11 and detonators 12 in the blasting boreholes 2 around the shaft 1 to be constructed, wherein the plastic pipes 10 are PVC pipes, and grooves are symmetrically formed on the sidewalls of the plastic pipes 10 for energy gathering in blasting; sealing the orifices of the plastic pipes 10 with stemming after charging, laying detonating tubes 9 over the entire length of the plastic pipes 10 and taking measures to protect the detonating tubes 9 from damage in the lowering process, and connecting the detonating tubes 9 to an initiator 8;

step 4: detonating the explosives in a simultaneous detonation mode after the preparatory work is finished, and pulling the water-rich porous rock stratum 5 between the blasting boreholes 2 apart through one or more blasts to form a circle of penetrating grouting cracks, or crushing the rock stratum to form a good permeability channel for grouting fluid, wherein the blasting scheme involves blasting once or multiple times according to the entire height or segmentation height of the water-rich porous rock stratum 5;

step 5: perforating the blasted boreholes to the depth of the borehole bottom, and then grouting the perforated boreholes in an orifice grouting manner, wherein cement-based grouting materials, such as cement single-fluid slurry and cement-water glass two-fluid slurry, are injected; before grouting, inspecting the groutability of the grouting fluid in the water-rich porous rock stratum 5 between the boreholes through a drilling peeping instrument; if it is inspected that the groutability is poor, blasting again until the requirements are met; and before and after grouting, carrying out a pumping test through the pumping inspection hole 3 in the center of the shaft 1 to check the change in water inflow of the shaft; and

step 6: when the water pumping of the pumping inspection hole 3 in the center of the shaft 1 shows that a complete grouting water-proof curtain has been formed, excavating the shaft according to the designed shaft parameters.

Embodiment 2

As shown in FIG. 4, a construction method for forming a water-proof grouting curtain in a water-rich porous rock stratum by blasting, comprising the following steps:

step 1: as shown in FIG. 5, constructing two circles of blasting boreholes 2 on the periphery of a shaft to be constructed with the center of the shaft 1 as the circle center, wherein the spacing between adjacent blasting boreholes 2 is 1.5 m, and the interval between the first circle and the

DESCRIPTION

second circle is 2 m, and vertically drilling downwards from the ground with a drilling rig, wherein the first circle of blasting boreholes 2 passes through the first layer of water-rich porous rock stratum 5 and reaches the first layer of impermeable stratum 6, and the second circle of blasting boreholes 2 sequentially passes through the first layer of water-rich porous rock stratum 5 and the second layer of water-rich porous rock stratum 5 and reaches the second layer of impermeable stratum 6; respectively forming grooves with a depth of not greater than 10 cm on both sides of each blasting borehole 2 through high-pressure water jets, wherein the grooves can form cracks between the blasting boreholes 2; and drilling a pumping inspection hole 3 near the center of the shaft 1 to be constructed, and vertically drilling downwards from the ground with the drilling rig until it penetrates through the second layer of water-rich porous rock stratum 5 and reaches the second layer of impermeable stratum 6;

step 2: lowering seamless steel pipes with openings at the bottom into the constructed blasting boreholes 2 respectively, wherein the seamless steel pipes have the length passing through a topsoil or alluvium 4 and entering a stable rock stratum by a certain depth; and performing fixing the seamless steel pipes after the seamless steel pipes are lowered in place, the joint between the seamless steel pipes being the end-to-end butt welding connection of the seamless steel pipes through outer collars;

step 3: as shown in FIG. 3, sequentially lowering plastic pipes 10 loaded with water-gel explosive cartridges 11 and detonators 12 in the blasting boreholes 2 around the shaft 1 to be constructed, wherein the plastic pipes 10 are PVC pipes, and grooves are symmetrically formed on the sidewalls of the plastic pipes 10 for energy gathering in blasting; sealing the orifices of the plastic pipes 10 with stemming after charging, laying detonating tubes 9 over the entire length of the plastic pipes 10 and taking measures to protect the detonating tubes 9 from damage in the lowering process, and connecting the detonating tubes 9 to an initiator 8;

step 4: detonating the explosives in a millisecond delay detonation mode after the preparatory work is finished, and pulling the water-rich porous rock stratum 5 between the blasting boreholes 2 apart through one or more blasts to form a circle of penetrating grouting cracks, or crushing the rock stratum to form a good permeability channel for grouting fluid, wherein the blasting scheme involves blasting once or multiple times according to the entire height or segmentation height of the water-rich porous rock stratum 5;

DESCRIPTION

step 5: perforating the blasted boreholes to the depth of the borehole bottom, and then grouting the perforated boreholes in an orifice grouting manner, wherein chemical grouting materials, such as polyurethanes and epoxy resins, are injected; before grouting, inspecting the groutability of the grouting fluid in the water-rich porous rock stratum 5 between the boreholes through a drilling peeping instrument; if it is inspected that the groutability is poor, blasting again until the requirements are met; and before and after grouting, carrying out a pumping test through the pumping inspection hole 2 in the center of the shaft 1 to check the change in water inflow of the shaft; and

step 6: when the water pumping of the pumping inspection hole 3 in the center of the shaft 1 shows that a complete grouting water-proof curtain has been formed, excavating the shaft according to the designed shaft parameters.

Embodiment 3

In addition to the above two embodiments, the water-proof grouting curtain construction method of the present invention is also suitable for other areas that require water-proof construction, such as tunnel excavation and coal mining. The drilling arrangement can be linear according to needs, as shown in FIG. 6. The remaining construction steps are the same as in Embodiment 1.

CLAIMS

What is claimed is:

1. A construction method for forming a water-proof grouting curtain in a water-rich porous rock stratum by blasting, comprising the following steps:

step 1: constructing a plurality of blasting boreholes on the periphery of a shaft to be constructed, and vertically drilling downwards from the ground with a drilling rig until it penetrates through the water-rich porous rock stratum and reaches an impermeable stratum; and drilling a pumping inspection hole near the center of the shaft to be constructed, and vertically drilling downwards from the ground with the drilling rig until it penetrates through the water-rich porous rock stratum and reaches the impermeable stratum;

step 2: lowering seamless steel pipes with openings at the bottom into the constructed blasting boreholes respectively, wherein the seamless steel pipes have the length passing through a topsoil or alluvium and entering a stable rock stratum by a certain depth, and fixing the seamless steel pipes in place after the seamless steel pipes are lowered into position;

step 3: lowering plastic pipes loaded with water-resistant explosives and detonators in the blasting boreholes around the shaft to be constructed, and connecting the detonating tubes to an initiator;

step 4: detonating the explosives, and pulling the water-rich porous rock stratum between the boreholes apart through one or more blasts to form a circle of penetrating grouting cracks;

step 5: perforating the blasted boreholes to the depth of the borehole bottom, and then grouting the perforated borehole; and

step 6: excavating the shaft according to the designed shaft parameters when a complete grouting water-proof curtain has been formed.

2. The construction method for forming a water-proof grouting curtain in a water-rich porous rock stratum by blasting according to claim 1, wherein orifices of the plastic pipes are sealed with stemming after charging.

3. The construction method for forming a water-proof grouting curtain in a water-rich porous

CLAIMS

rock stratum by blasting according to any one of the preceding claims, wherein detonating tubes are laid over the entire length of the plastic pipes.

4. The construction method for forming a water-proof grouting curtain in a water-rich porous rock stratum by blasting according to any one of the preceding claims, wherein explosives are used to crush the rock stratum to form a good permeability channel for grouting fluid.

5. The construction method for forming a water-proof grouting curtain in a water-rich porous rock stratum by blasting according to any one of the preceding claims, wherein method incorporates a blasting scheme that involves blasting once or multiple times according to the entire height or segmentation height of the water-rich porous rock stratum.

6. The construction method for forming a water-proof grouting curtain in a water-rich porous rock stratum by blasting according to any one of the preceding claims, wherein the groutability of the grouting fluid in the water-rich porous rock stratum between the boreholes is inspected.

7. The construction method for forming a water-proof grouting curtain in a water-rich porous rock stratum by blasting according to any one of the preceding claims, wherein the groutability of the grouting fluid in the water-rich porous rock stratum between the boreholes is inspected through a drilling peeping instrument.

8. The construction method for forming a water-proof grouting curtain in a water-rich porous rock stratum by blasting according to any one of the preceding claims, wherein a pumping test is carried out through the pumping inspection hole in the center of the shaft to check the change in water inflow of the shaft.

9. The construction method for forming a water-proof grouting curtain in a water-rich porous rock stratum by blasting according to any one of the preceding claims, wherein determination that a complete grouting water-proof curtain has been formed is determined via inspecting the water pumping of the pumping inspection hole.

10. The construction method for forming a water-proof grouting curtain in a water-rich porous rock stratum by blasting according to any one of the preceding claims, wherein at least a circle of the blasting boreholes is uniformly arranged at intervals from inside to outside on the

CLAIMS

periphery of the shaft with the center of the shaft as the circle center.

11. The construction method for forming a water-proof grouting curtain in a water-rich porous rock stratum by blasting according to any one of the preceding claims, wherein the spacing between adjacent blasting boreholes is 1-2 m.

12. The construction method for forming a water-proof grouting curtain in a water-rich porous rock stratum by blasting according to claim 10, wherein the interval between two adjacent circles of blasting boreholes is 1-3 m.

13. The construction method for forming a water-proof grouting curtain in a water-rich porous rock stratum by blasting according to claim 1, wherein grooves are formed on two sides of each blasting borehole, respectively.

14. The construction method for forming a water-proof grouting curtain in a water-rich porous rock stratum by blasting according to any one of claims 1 to 8, wherein in step 2, grooves are symmetrically formed on the sidewalls of the plastic pipes for energy gathering in blasting.

15. The construction method for forming a water-proof grouting curtain in a water-rich porous rock stratum by blasting according to any one of claims 1 to 8, wherein in step 2, the water-resistant explosives are water-gel explosives.

16. The construction method for forming a water-proof grouting curtain in a water-rich porous rock stratum by blasting according to any one of claims 1 to 8, wherein in step 3, an explosive detonation mode is simultaneous detonation or millisecond delay detonation.

17. The construction method for forming a water-proof grouting curtain in a water-rich porous rock stratum by blasting according to any one of claims 1 to 8, wherein in step 4, a grouting material is a cement-based grouting material or a chemical grouting material.

DRAWINGS

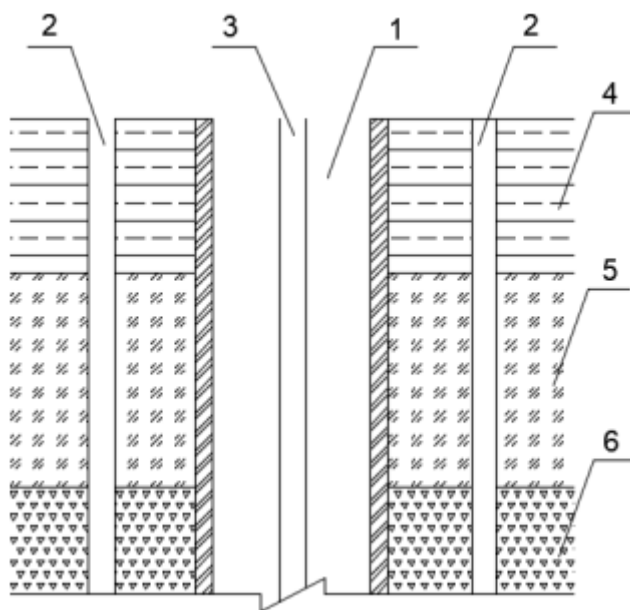


FIG. 1

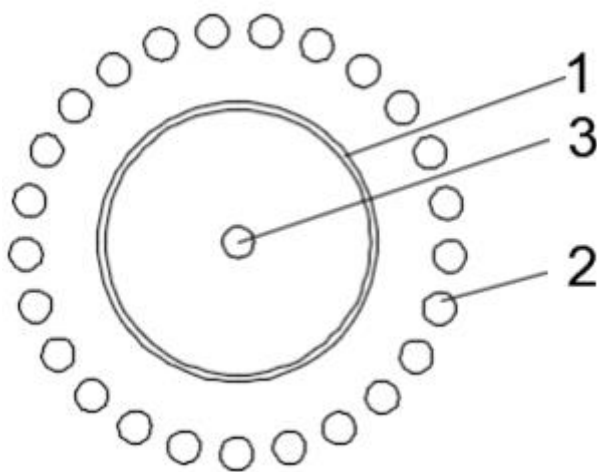


FIG. 2

DRAWINGS

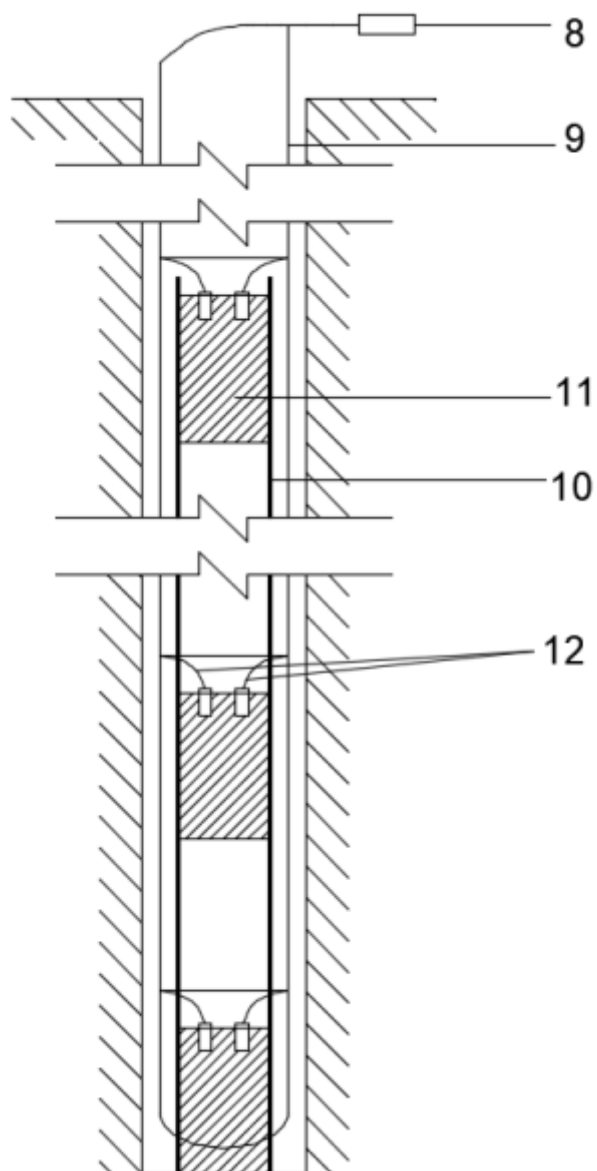


FIG. 3

DRAWINGS

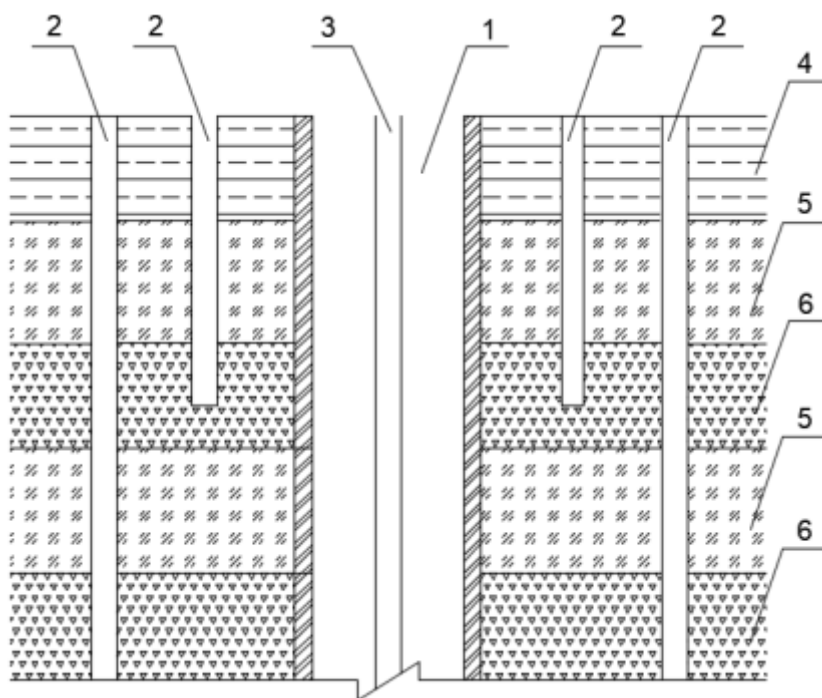


FIG. 4

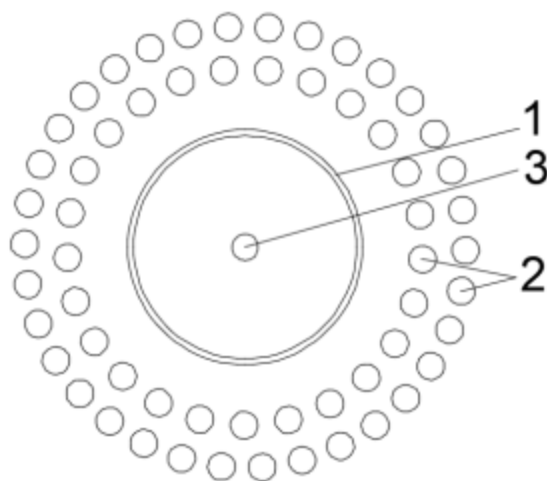
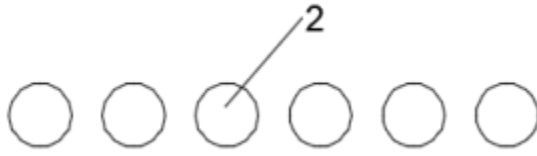


FIG. 5

DRAWINGS

**FIG. 6**