

FRACTURE GROUTING MACHINE AND METHOD FOR DAM SEEPAGE PREVENTION AND REPAIR

Field of the Invention

5 The present invention relates to the technical field of fracture grouting, and particularly to a fracture grouting machine and method for dam seepage prevention and repair.

Background to the Invention

10 Fracture grouting is one of the common methods for grouting and reinforcing soil. When the grout is injected into the soil, it first compacts or penetrates the surrounding soil. When the grout pressure exceeds a certain value, the grout will split the soil, form grout veins and expand, creating a vein-like consolidated body that can reinforce the soil. It can be applied to both sand layers with good permeability and cohesive soils with poor permeability, and is often used for seepage prevention and repair of dams.

15 The patent with publication number CN117489325A discloses a directional induced grouting device for fracture grouting. The drilling head is used to drill the surface of the construction site to facilitate subsequent grouting operations. Both sides of the base frame are equipped with rollers, and a positioning device is arranged inside the base frame. By setting the positioning device, the position of each hole drilled by the drilling head can be recorded. Then, electrical energy is transmitted to the vibration generator through the infrared receiver, so that the check valve pipe located inside the storage frame can be accurately placed into the hole. Meanwhile, the drilling head in front of the device continues to drill while the check valve pipe is being placed, ensuring that the spacing between each hole is consistent.

25 However, the above-mentioned prior art has the following technical defects:

First, since the check valve pipe is not rotated after being inserted into the borehole, and the construction personnel do not know the hardness of the soil on the inner wall of the borehole, when the hard soil is opposite to the injection hole of the check valve pipe, the

grout ejected from the injection hole impacts the hard soil, resulting in small fracture cracks, which directly affects the fracture grouting effect.

Second, each injection hole of the check valve pipe is provided with a piston to prevent mud from entering the check valve pipe through the injection hole when the check valve pipe is inserted into the borehole. However, if the stability between the piston and the injection hole is poor, the mud in the borehole can easily push the piston into the check valve pipe, causing mud to enter the check valve pipe. The mud mixed into the pipe can affect the fluidity and uniformity of the subsequent grout. Therefore, before inserting the check valve pipe, the staff needs to manually detect the stability of the piston. However, there are many injection holes on the pipe, and the detection takes a long time.

In summary, the prior art still has room for improvement in improving the fracture grouting effect and detecting the stability of the piston in each injection hole of the check valve pipe. Therefore, it is necessary to develop a device that can improve the fracture grouting effect and detect the stability of the pistons in each injection hole of the check valve pipe.

Statement of Invention

To address the above-mentioned problems, the present invention provides a fracture grouting machine and method for dam seepage prevention and repair, adopting the following technical solutions.

First aspect, a fracture grouting machine for dam seepage prevention and repair includes a plate-shaped vehicle frame. A rectangular groove is disposed at an edge of an upper surface of the vehicle frame, and a crawler vehicle is arranged below the vehicle frame.

The machine further includes a fixing mechanism. The fixing mechanism includes a rectangular seat arranged above the rectangular groove, a first gear is rotatably mounted on a lower side of the rectangular seat, rectangular grooves are disposed on side surfaces of the rectangular seat and the first gear, and a set of fixing clamps is arranged in the rectangular groove of the first gear.

A compaction mechanism is arranged below the fixing mechanism. The compaction

mechanism includes a set of L-shaped plates positioned on two sides of the rectangular seat, a first bevel gear is mounted on a lower side of the first gear, second bevel gears are rotatably mounted on side surfaces of the L-shaped plates and adapted to mesh with the first bevel gear, ends of the second bevel gears penetrate through the L-shaped plates and are mounted with turntables, sliders constrained to vertical movement are arranged below the turntables, and a set of compaction plates forming a circular ring is arranged below the two sliders.

Preferably, a drive motor is mounted on an upper side of the rectangular seat, and a drive end of the drive motor penetrates through the rectangular seat and is mounted with a second gear meshing with the first gear.

Preferably, connecting plates are rotatably mounted at lateral edges of the turntables, lower ends of the connecting plates are rotatably connected to the adjacent sliders, and a set of second electric push rods with telescopic arm ends respectively connected to the two L-shaped plates is mounted on the upper side of the rectangular seat.

Preferably, the machine further includes a detection mechanism. The detection mechanism includes a toothed disc rotatably mounted on the upper side of the rectangular seat and positioned directly above the first gear, and a rack meshing with the toothed disc is mounted on a side surface of one of the L-shaped plates.

Preferably, a plurality of uniformly distributed arc-shaped grooves are annularly disposed on an upper side of the toothed disc, a sliding seat is slidably arranged in each of the arc-shaped grooves, and fixing blocks are mounted at upper ends of the sliding seats.

Preferably, telescopic rods are mounted on side surfaces of the fixing blocks, detection wheels are mounted at ends of the telescopic rods, and circular members are mounted at end portions of the telescopic rods.

Preferably, second springs are arranged between the circular members and the fixing blocks, rectangular plates are mounted on upper sides of the fixing blocks, and pressure sensors are mounted on side surfaces of the rectangular plates.

Preferably, extension rods with ends penetrating through and slidably connected to the

rectangular plates are mounted on side surfaces of the circular members, and pressure plates are mounted at the ends of the extension rods.

Preferably, a corresponding mounting plate is mounted on the upper side of the rectangular seat at one side of each of the fixing blocks, and a strip-shaped plate penetrating through the corresponding mounting plate is mounted on the other side of each of the fixing blocks.

In another aspect, the present invention further provides a fracture grouting method for dam seepage prevention and repair, including the following steps:

S1: drilling the dam body, drilling the dam body ground using a descending and rotating drill bit;

S2: inserting the pipeline, inserting a check valve pipe into the borehole while detecting the inserted check valve pipe using the detection mechanism;

S3: fixing the pipeline, fixing the check valve pipe that has entered the borehole using the fixing mechanism;

S4: rotating the pipeline, rotating the check valve pipe via the fixing mechanism in the grouting process to change the grout injection direction;

S5: compressing the soil, re-compacting the soil at the borehole port after the rotation of the check valve pipe;

S6: restoring the structure, releasing the fixation of the check valve after the grouting in this borehole is completed.

In summary, the present invention includes at least the following technical advantages of the fracture grouting machine and method for dam seepage prevention and repair.

1. By incorporating a fixing mechanism and a compaction mechanism, the present invention enables the check valve pipe to rotate after a period of fracture grouting via the fixing mechanism, thereby changing the orientation of each injection hole of the check valve pipe, allowing the injection holes to face the soft soil on the inner wall of the borehole, facilitating the generation of larger fracture cracks. Additionally, multiple rotations can

create multiple new fracture cracks on the inner wall soil of the borehole, increasing fracture branches and enhancing the fracture grouting effect, thus improving the repair effect on the dam. At the same time, during the rotation of the first gear, the compaction mechanism is driven to re-compact the soil at the borehole port that has become loose due to the rotation of the check valve pipe.

2. When the check valve pipe is inserted into the borehole, the detection mechanism is configured to use the rebound of the compressed second spring to make the detection wheel squeeze the piston inside the injection hole of the check valve pipe. This simulates the mud pressure applied to the piston, achieving automatic detection of the stability of the piston in each injection hole of the pipe. Meanwhile, it eliminates the need for manual detection by workers, reducing labor intensity. Additionally, the detection is carried out during the insertion of the check valve pipe into the borehole, and the detection is completed simultaneously with the insertion, resulting in short overall time consumption and high detection efficiency.

Brief Description of the Drawings

The present invention is further described below with reference to the accompanying figures and examples.

FIG. 1 is a schematic structural diagram of the present invention;

FIG. 2 is a schematic diagram of the main structure of the present invention;

FIG. 3 is a schematic structural diagram of a fixing mechanism of the present invention;

FIG. 4 is a side view of the fixing mechanism of the present invention;

FIG. 5 is a schematic structural diagram of a compaction mechanism of the present invention;

FIG. 6 is a side view of the compaction mechanism of the present invention;

FIG. 7 is a schematic structural diagram of the compaction mechanism in the second state of the present invention;

FIG. 8 is a schematic structural diagram of the working state of the present invention;

FIG. 9 is a schematic structural diagram of a detection mechanism of the present invention;

FIG. 10 is a side view of the detection mechanism of the present invention;

FIG. 11 is a partial cross-sectional view of the detection mechanism of the present
5 invention;

FIG. 12 is a side view of the present invention;

FIG. 13 is a schematic structural diagram of an adjustment mechanism of the present
invention; and

FIG. 14 is a schematic diagram of the disassembled state of the adjustment mechanism of
10 the present invention.

Reference numerals and denotations thereof: 1-vehicle frame; 2-crawler vehicle; 3-fixing
mechanism; 301-rectangular seat; 302-first gear; 303-rectangular groove; 304-first electric
push rod; 305-fixing clamp; 306-drive motor; 307-second gear; 4-compaction mechanism;
401-L-shaped plate; 402-turntable; 403-first bevel gear; 404-second bevel gear;
15 405-connecting plate; 406-slide bar; 407-slider; 408-L-shaped fixing frame; 409-upper
plate; 410-round bar; 411-compaction plate; 412-first spring; 413-limiting plate; 414-limiting
block; 415-second electric push rod; 416-slide plate; 417-side plate; 5-detection
mechanism; 501-toothed disc; 502-rack; 503-arc-shaped groove; 504-mounting plate;
505-fixing block; 506-sliding seat; 507-strip-shaped plate; 508-telescopic rod; 509-circular
20 member; 510-detection wheel; 511-second spring; 512-rectangular plate; 513-pressure
sensor; 514-extension rod; 515-pressure plate; 516-protection plate; 6-adjustment
mechanism; 601-trough-shaped frame; 602-adjustment rod; 603-adjustment seat;
604-adjustment hole; 605-positioning hole; 606-pin; 7-control console; 8-L-shaped fixing
plate; 9-first hydraulic cylinder; 10-push component; 11-drilling motor; 12-drill pipe; 13-drill
25 bit; 14-mounting cylinder; 15-second hydraulic cylinder; and 16-lower pressure plate.

Detailed Description

The examples of the present invention will be described in detail with reference to FIGS.

1-14.

Examples of the present invention provide a fracture grouting machine and method for dam seepage prevention and repair. The check valve pipe rotates after a period of fracture grouting via the fixing mechanism, thereby changing the orientation of each injection hole of the check valve pipe, allowing the injection holes to face the soft soil on the inner wall of the borehole, facilitating the generation of larger fracture cracks. Additionally, multiple rotations can create multiple new fracture cracks on the inner wall soil of the borehole, increasing fracture branches and enhancing the fracture grouting effect.

Example 1: as shown in FIG. 1, the machine includes a plate-shaped vehicle frame 1. A rectangular groove is disposed at an edge of an upper surface of the vehicle frame 1, and a crawler vehicle 2 is arranged below the vehicle frame 1. The vehicle frame 1 is used for mounting other structures of the device, while the crawler vehicle 2 is used for device movement.

As shown in FIGS. 1-3, the machine further includes a fixing mechanism 3. The fixing mechanism 3 includes a rectangular seat 301 arranged above the rectangular groove, a first gear 302 is rotatably mounted on a lower side of the rectangular seat 301, a drive motor 306 is mounted on an upper side of the rectangular seat 301, and a drive end of the drive motor 306 penetrates through the rectangular seat 301 and is mounted with a second gear 307 meshing with the first gear 302. Operation of the drive motor 306 drives the second gear 307 to rotate, and the rotating second gear 307 drives the first gear 302 meshing with it to rotate.

As shown in FIGS. 3 and 4, rectangular grooves 303 are disposed on side surfaces of the rectangular seat 301 and the first gear 302, and a set of fixing clamps 305 is arranged in the rectangular groove 303 of the first gear 302. A set of first electric push rods 304 fixedly connected to an inner wall of the rectangular groove 303 is mounted on a side surface of each of the fixing clamps 305. The check valve pipe is placed between the two fixing clamps 305, and then the two sets of first electric push rods 304 extend to drive the two fixing clamps 305 to move closer to each other for clamping the check valve pipe.

In summary, the check valve pipe is placed between the two fixing clamps 305, and then

the two sets of first electric push rods 304 extend to drive the two fixing clamps 305 to move closer to each other to clamp the check valve pipe. The drive motor 306 operates to drive the second gear 307 to rotate, and the rotating second gear 307 drives the first gear 302 meshing with it to rotate, thereby driving the check valve pipe to rotate, changing the orientation of the injection holes on the check valve pipe, and thus altering the direction of grout ejection to fracture the soil in multiple directions and increase fracture branches.

As shown in FIGS. 2 and 5, a compaction mechanism 4 is arranged below the fixing mechanism 3. The compaction mechanism 4 includes a set of L-shaped plates 401 positioned on two sides of the rectangular seat 301. Slide plates 416 penetrating through the L-shaped plates 401 on the same side are mounted on both sides of the rectangular seat 301, and side plates 417 are mounted at ends of the slide plates 416. The moving L-shaped plates 401 slide on the slide plates 416, while the side plates 417 are used to limit the L-shaped plates 401 to prevent them from detaching from the slide plates 416.

As shown in FIGS. 5-7, a first bevel gear 403 is mounted on a lower side of the first gear 302, second bevel gears 404 are rotatably mounted on side surfaces of the L-shaped plates 401 and adapted to mesh with the first bevel gear 403, ends of the second bevel gears 404 penetrate through the L-shaped plates 401 and are mounted with turntables 402. When the second bevel gears 404 mesh with the first bevel gear 403, the rotating first bevel gear 403 drives the second bevel gears 404 to rotate, thereby driving the turntables 402 to rotate.

As shown in FIGS. 5-7, sliders 407 are arranged below the turntables 402, and a set of slide bars 406 penetrating through the slider 407 on the same side is mounted on a lower side of each of the L-shaped plates 401. A limiting block 414 is jointly mounted at lower ends of two slide bars 406 of each set. Connecting plates 405 are rotatably mounted at lateral edges of the turntables 402, lower ends of the connecting plates 405 are rotatably connected to the adjacent sliders 407. The rotating turntables 402 drive the sliders 407 to slide on the slide bars 406 through the connecting plates 405, and the limiting blocks 414 are used to limit the sliders 407.

As shown in FIGS. 5-7, an upper plate 409 is arranged directly above each compaction

plate 411, and L-shaped fixing frames 408 fixedly connected to the sliders 407 on the same side are mounted on upper sides of the upper plates 409. The moving sliders 407 drive the upper plates 409 to move through the L-shaped fixing frames 408.

5 As shown in FIGS. 5-7, a set of compaction plates 411 forming a circular ring is arranged below the two sliders 407. A set of round bars 410 penetrating through the upper plates 409 above are mounted on upper sides of the compaction plates 411, and a limiting plate 413 is mounted at an upper end of each of the round bars 410. A set of first springs 412 is arranged between the compaction plates 411 and the upper plates 409. The descending upper plates 409 drive the compaction plates 411 to descend, and when the compaction
10 plates 411 contact the soil, the continuously descending upper plates 409 compress the first springs 412, and the compressed first springs 412 exert a rebound force on the soil through the compaction plates 411.

As shown in FIGS. 5-7, a set of second electric push rods 415 with telescopic arm ends respectively connected to the two L-shaped plates 401 is mounted on the upper side of the
15 rectangular seat 301. Shortening of the two second electric push rods 415 drive the two L-shaped plates 401 to move closer to each other.

In summary, the two second electric push rods 415 shorten to drive the two L-shaped plates 401 to move closer to each other until the two second bevel gears 404 mesh with the first bevel gear 403. When the first gear 302 rotates, it drives the second bevel gears
20 404 to rotate through the first bevel gear 403, and the rotating second bevel gears 404 pull the sliders 407 to move up and down through the turntables 402 and the connecting plates 405. The ascending sliders 407 drive the compaction plates 411 to ascend, while the descending sliders 407 also drive the compaction plates 411 to descend. When the compaction plates 411 contact the soil, the continuously descending upper plates 409
25 compress the first springs 412, and the compressed first springs 412 exert a rebound force on the soil through the compaction plates 411 to re-compact the soil at the borehole port loosened due to the rotation of the check valve pipe.

As shown in FIGS. 1, 8 and 9, the machine further includes a detection mechanism 5. The detection mechanism 5 includes a toothed disc 501 rotatably mounted on the upper side of

the rectangular seat 301 and positioned directly above the first gear 302, and a rack 502 meshing with the toothed disc 501 is mounted on a side surface of one of the L-shaped plates 401. The moving L-shaped plate 401 drives the rack 502 to move, and the moving rack 502 drives the toothed disc 501 to rotate.

5 As shown in FIGS. 9-11, a plurality of uniformly distributed arc-shaped grooves 503 are annularly disposed on an upper side of the toothed disc 501, a sliding seat 506 is slidably arranged in each of the arc-shaped grooves 503, and fixing blocks 505 are mounted at upper ends of the sliding seats 506. The rotating toothed disc 501 drives the sliding seats 506 to slide toward the center through the arc-shaped grooves 503, thereby making the
10 four fixing blocks 505 move closer to each other.

As shown in FIG. 11, telescopic rods 508 are mounted on side surfaces of the fixing blocks 505, detection wheels 510 are mounted at ends of the telescopic rods 508, and circular members 509 are mounted at end portions of the telescopic rods 508. The moving fixing blocks 505 drive the telescopic rods 508 to move, and when the check valve pipe is
15 inserted, the detection wheels 510 are used to roll on the side surface of the check valve pipe.

As shown in FIG. 11, second springs 511 are arranged between the circular members 509 and the fixing blocks 505, extension rods 514 with ends penetrating through and slidably connected to the rectangular plates 512 are mounted on side surfaces of the circular
20 members 509, and pressure plates 515 are mounted at the ends of the extension rods 514. When the telescopic rods 508 contract, the second springs 511 are compressed, and the pressure plates 515 are driven to move through the circular members 509 and the extension rods 514.

As shown in FIG. 11, rectangular plates 512 are mounted on upper sides of the fixing
25 blocks 505, and pressure sensors 513 are mounted on side surfaces of the rectangular plates 512. The moving pressure plates 515 compress the pressure sensors 513.

As shown in FIG. 11, a corresponding mounting plate 504 is mounted on the upper side of the rectangular seat 301 at one side of each of the fixing blocks 505, and a strip-shaped plate 507 penetrating through the corresponding mounting plate 504 is mounted on the

other side of each of the fixing blocks 505. Protection plates 516 are mounted at ends of the strip-shaped plates 507, and the moving fixing blocks 505 drive the strip-shaped plates 507 to slide on the mounting plates 504.

5 In summary, the check valve pipe is placed between the four detection wheels 510. When the second electric push rods 415 shorten to drive the two L-shaped plates 401 to move closer to each other, the rack 502 is also driven to move. The moving rack 502 drives the toothed disc 501 to rotate, and the four fixing blocks 505 are made to move closer to each other through the arc-shaped grooves 503 and the mounting plates 504. Each moving fixing block 505 presses against the side wall of the check valve pipe, compressing the telescopic rods 508, compressing the second springs 511 through the circular members 10 509, and driving the pressure plates 515 to move through the extension rods 514. The check valve pipe is rotated to make each detection wheel 510 located directly below a set of injection holes, and then the check valve pipe is lowered. When the detection wheel 510 contacts the piston in the injection hole, the compressed second spring 511 applies a rebound force to the piston through the detection wheel 510 to simulate the extrusion of the piston by the mud in the borehole. When the detection wheel 510 presses the piston to move into the injection hole, the moving circular member 509 presses the pressure sensor 513 through the pressure plate 515. When the pressure sensor 513 is under pressure, it indicates that the piston has moved inward, thereby signifying that the piston in the injection hole is too loose, and the staff replaces the piston in this injection hole. When the check valve pipe completely passes between the four detection wheels 510 and no pressure sensor 513 is under pressure, it indicates that the pistons in each injection hole of the check valve pipe are stable, and the mud will not push the pistons out after entering the borehole.

25 As shown in FIG. 12, mounting cylinders 14 are mounted at four corners of the vehicle frame 1. A second hydraulic cylinder 15 is mounted in each of the mounting cylinders 14, and lower pressure plates 16 are mounted at lower ends of the second hydraulic cylinders 15. The four second hydraulic cylinders 15 descend to drive the lower pressure plates 16 to descend and contact the ground, enhancing the stability of the entire device.

30 As shown in FIG. 12, a control console 7 is mounted on an upper side of the vehicle frame

1 at a side of the fixing mechanism 3. Two sets of L-shaped fixing plates 8 are mounted on the upper side of the rectangular seat 301 in a rectangular shape, and each set of two L-shaped fixing plates 8 are jointly mounted with a first hydraulic cylinder 9. The device is controlled through the control console 7, and the first hydraulic cylinders 9 extend to drive the vehicle frame 1 to rise through the L-shaped fixing plates 8, while also driving the compaction mechanism 4 and the detection mechanism 5 to rise.

Example 2: on the basis of Example 1, as shown in FIG. 12, a push component 10 is mounted on the upper side of the vehicle frame 1 at a side of the control console 7. A drilling motor 11 is mounted at a pushing end of the push component 10, a drill pipe 12 is mounted at a drive end of the drilling motor 11, and a drill bit 13 is arranged at a lower end of the drill pipe 12. The push component 10 drives the drilling motor 11 to descend, while the drilling motor 11 drives the drill pipe 12 and the drill bit 13 to descend, so that the descending and rotating drill bit 13 drills a hole in the dam body.

As shown in FIGS. 12-14, an adjustment mechanism 6 is arranged below the two first hydraulic cylinders 9. The adjustment mechanism 6 includes two trough-shaped frames 601 fixedly connected to the vehicle frame 1. Adjustment rods 602 are mounted between inner side surfaces of the trough-shaped frames 601, and adjustment seats 603 fixedly connected to the first hydraulic cylinders 9 are slidably arranged on the adjustment rods 602. Sliding the adjustment seats 603 on the adjustment rods 602 drives the first hydraulic cylinders 9 to move, thereby driving the vehicle frame 1 to move and changing the distance between the vehicle frame 1 and the drill bit 13 to adapt to various repair requirements.

As shown in FIGS. 12-14, a plurality of uniformly distributed adjustment holes 604 are disposed on side surfaces of the trough-shaped frames 601, and positioning holes 605 aligned with one of the adjustment holes 604 are disposed on side surfaces of the adjustment seats 603. Pins 606 are arranged between the positioning holes 605 and the aligned adjustment holes 604. The adjustment seats 603 are fixed by the pins 606 inserted between the positioning holes 605 and the corresponding adjustment holes 604, and the fixation of the adjustment seats 603 is released when the pins 606 are pulled out.

A fracture grouting method for dam seepage prevention and repair includes the following

step.

S1: drilling the dam body, the dam body ground is drilled using a descending and rotating drill bit 13. Specifically, the device is moved by the crawler vehicle 2 until the drill bit 13 is directly aligned with the position where the dam body needs to be drilled. Then, the push component 10 drives the drilling motor 11 to descend, while the drilling motor 11 drives the drill pipe 12 and the drill bit 13 to descend, so that the descending and rotating drill bit 13 drills a hole in the dam body ground. After that, the push component 10 drives the push component 10 to rise to move the drill pipe 12 and the drill bit 13 out of the borehole, and sealing mud is added into the borehole. Then, the crawler vehicle 2 moves linearly to align the vehicle frame 1 with the borehole, and the push component 10 and the drilling motor 11 continue to operate to drill the dam body ground directly below.

S2: inserting the pipeline, a check valve pipe is inserted into the borehole while the inserted check valve pipe is detected using the detection mechanism 5. Specifically, the check valve pipe is placed between the four detection wheels 510. When the second electric push rods 415 shorten to drive the two L-shaped plates 401 to move closer to each other, the rack 502 is also driven to move. The moving rack 502 drives the toothed disc 501 to rotate, and the four fixing blocks 505 are made to move closer to each other through the arc-shaped grooves 503 and the mounting plates 504. Each moving fixing block 505 presses against the side wall of the check valve pipe, compressing the telescopic rods 508, compressing the second springs 511 through the circular members 509, and driving the pressure plates 515 to move through the extension rods 514. The check valve pipe is rotated to make each detection wheel 510 located directly below a set of injection holes, and then the check valve pipe is lowered. When the detection wheel 510 contacts the piston in the injection hole, the compressed second spring 511 applies a rebound force to the piston through the detection wheel 510 to simulate the extrusion of the piston by the mud in the borehole. When the detection wheel 510 presses the piston to move into the injection hole, the moving circular member 509 presses the pressure sensor 513 through the pressure plate 515. When the pressure sensor 513 is under pressure, it indicates that the piston has moved inward, thereby signifying that the piston in the injection hole is too loose, and the staff replaces the piston in this injection hole. When the check valve pipe

completely passes between the four detection wheels 510 and no pressure sensor 513 is under pressure, it indicates that the pistons in each injection hole of the check valve pipe are stable, and the mud will not push the pistons into the check valve pipe after entering the borehole.

5 S3: fixing the pipeline, the check valve pipe that has entered the borehole is fixed using the fixing mechanism 3. Specifically, the check valve pipe continues to descend until its upper end is close to the two fixing clamps 305. Soil is added to the borehole port to seal the upper port of the borehole. The drive motor 306 drives the second gear 307 to rotate, thereby driving the first gear 302 to rotate and the first bevel gear 403 to rotate. Meanwhile,
10 when the two second electric push rods 415 shorten, the two second bevel gears 404 are driven to mesh with the first bevel gear 403. The rotating first bevel gear 403 drives the second bevel gears 404 to rotate, and the rotating second bevel gears 404 pull the sliders 407 to descend through the turntables 402 and the connecting plates 405. The descending sliders 407 drive the compaction plates 411 to descend to compact the soil at the borehole port. Then, the two sets of first electric push rods 304 extend to drive the two fixing clamps
15 305 to move closer to each other until the check valve pipe is clamped.

S4: rotating the pipeline, the check valve pipe is rotated via the fixing mechanism 3 in the grouting process to change the grout injection direction. Specifically, high-pressure grout is sent into the check valve pipe to make the grout open the piston in the injection hole and
20 shoot toward the inner wall of the borehole, generating fracture cracks in the soil and allowing the grout to diffuse along the cracks. After a period of time, the drive motor 306 drives the second gear 307 to rotate, and the rotating second gear 307 drives the first gear 302 to rotate until it rotates by ten degrees. Then, the drive motor 306 is turned off, and the rotating first gear 302 drives the check valve pipe to rotate to change the orientation of the
25 injection holes of the check valve pipe. At this time, the grout ejected from the injection holes will generate new fracture cracks in the soil on the inner wall of the borehole. The above operation is repeated to continue changing the direction, generating multiple new fracture cracks in the soil on the inner wall of the borehole, increasing fracture branches, and improving the repair effect.

30 S5: compressing the soil, the soil at the borehole port is re-compacted after the rotation of

the check valve pipe. Specifically, when the first gear 302 rotates, it drives the second bevel gears 404 to rotate through the first bevel gear 403, and the rotating second bevel gears 404 pull the sliders 407 to move up and down through the turntables 402 and the connecting plates 405. The ascending sliders 407 drive the compaction plates 411 to ascend, while the descending sliders 407 also drive the compaction plates 411 to descend. When the compaction plates 411 contact the soil, the continuously descending upper plates 409 compress the first springs 412, and the compressed first springs 412 exert a rebound force on the soil through the compaction plates 411 to re-compact the soil at the borehole port loosened due to the rotation of the check valve pipe.

S6: restoring the structure, the fixation of the check valve is released after the grouting in this borehole is completed, and then the fixing mechanism 3 rises to drive the compaction mechanism 4 to move above the check valve pipe. Specifically, after the grouting is completed, the two sets of first electric push rods 304 shorten to drive the two fixing clamps 305 to move away from each other to release the clamping of the check valve pipe. Then, the first hydraulic cylinders 9 extend to drive the fixing mechanism 3 to rise, while driving the compaction mechanism 4 to rise and move above the check valve pipe. The device moves to make the fixing mechanism 3 move above the next borehole, and then the above rising operation is repeated to continue grouting this borehole.

For those skilled in the art, it is obvious that the present invention is not limited to the details of the above-described exemplary examples, and the present invention may be implemented in other specific forms without departing from the spirit or basic characteristics of the present invention. Therefore, from any perspective, the examples are to be regarded as exemplary and non-limiting.

Furthermore, it is to be understood that although this specification is described in terms of examples, not every example only contains an independent technical solution. This narrative manner in the specification is only for clarity. Those skilled in the art will take the specification as a whole, and the technical solutions in the various examples may also be appropriately combined to form other examples that may be understood by those skilled in the art.