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(54) **COMBINED DOWN-THE-HOLE HAMMER**

(57) A combined down-the-hole hammer comprises a coupler (1), a bracket (3), plurality of impactors (4), a gas distributor (2). The coupler is configured to connect with a drill rod (5) and is internally provided with a first gas passage (10). plurality of impactors (4) are installed on the bracket (3), each of which is individually provided with a second gas passage (40), and an impact drill bit (45) of each of the impactors (4) can rotate around the axis per se. The gas distributor (2) is provided between the coupler (1) and the bracket (3). The gas distributor (2) is provided with a gas collection chamber (21) communicated with the first gas passage (10) and a plurality of gas-distributing paths (22) communicating the gas collection chamber (21) with the second gas passage of each of the impactors (4). The combined down-the-hole hammer has the following advantages: low cost, rational structure, easy maintenance, convenient assembly/disassembly, reliable seal, and high efficiency of energy utilization and boring.

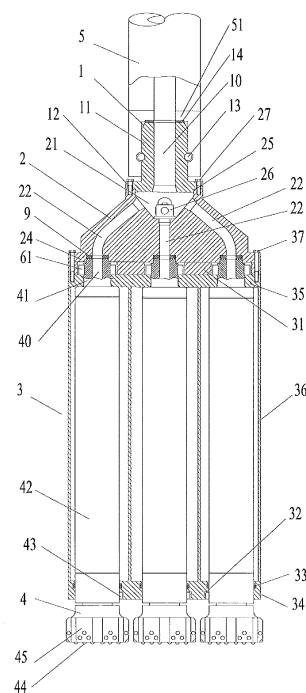


Fig. 2

Description

Field of the Invention

[0001] The disclosure relates to a combined down-the-hole hammer.

Background of the Invention

[0002] Generally, a drill bit is driven by a drill to drill holes on the strata in foundation pile construction, steel reinforcement cages are placed and concrete are filled in the holes subsequently, and foundation piles are formed after the concrete is hardened. However, the drill can hardly drill holes when encountering hard strata, especially rocks and an impactor (also known as a down-the-hole hammer) is needed for impact drilling. Because of the capability of drilling efficiently in hard rocks, the impactor is applied broadly to mining and basic construction of buildings.

[0003] The well-known impactor (published on pages 66 to 68 in the first chapter of China Mining Equipment Manual-Volume One, for example) is also generally called an integrated down-the-hole hammer in the industry, consisting of a conic thread joint 61', an impactor main body 62' including a piston, an impact drill bit 64' provided with a hard alloy head 63', and the diameter of the impactor is generally equal to or smaller than $\phi 300\text{mm}$, as shown in Fig. 16. During construction, the down-the-hole hammer is connected with the power head of the drill through a hollow drill rod. The power head drives the down-the-hole hammer to rotate, compressed air provided by an air compressor enters the impactor main body through the drill rod to drive the piston to strike the drill bit in a reciprocating manner frequently, and the impact energy is transferred to the hard alloy head of the drill bit to strike the rock in a reciprocating manner so as to break the rock. The rock fragments are discharged through an annular gap between the drill rod and the pore wall along with the gas discharged by the down-the-hole hammer to form a pile hole eventually.

[0004] The advantage is the highly-efficient drilling in hard strata, especially rocks. With the development of the foundation pile construction industry, however, the integrated down-the-hole hammer has the following shortages when the demands for drilling large-diameter foundation piles ($\phi 500$ to $\phi 800$ and diameters larger than $\phi 1000$) are increased:

1. large-diameter integrated down-the-hole hammers, which have high processing technological requirements and easily-caused quality problems, are hard to manufacture, and the manufacturing cost is relatively high;
2. because of the large size, the heavy weight and inconvenient maintenance and repair, the whole integrated down-the-hole hammer needs to be disassembled and repaired once a certain alloy head on

the drill is damaged during working, thus prolonging the construction period and resulting in relatively high cost;

3. because of the large diameter, the heavy weight and the connection method using the conic thread joint, the integrated down-the-hole hammer, which needs to be rotated integrally and tightened by a very large torque to reach the required tightness, is installed and disassembled on site inconveniently.

[0005] To solve the above shortages of the large-diameter integrated down-the-hole hammers, an American patent US 4429439 publishes another cluster down-the-hole hammer. As shown in Fig. 17, a large-diameter down-the-hole hammer consisting of 5 small-diameter impactors clustered by frames is connected with a drill rod and a gas inlet passage via conic thread joints and distributes compressed air to each small impactors via a transverse gas passage to drive the impactors to perform impact drilling.

[0006] However, the cluster down-the-hole hammer has the following disadvantages:

1. the corners for the compressed air to enter the impactors via the transverse gas passage are almost rectangular, which results in great pressure loss and low efficiency;
2. according to the arrangement of the small-diameter impactors, the drilling area covered by the central impactor is different from those of the surrounding impactors in the same rotating conditions, and the impacting frequency of the central impactor (acting) should be different. However, the gas pressure which is the same in the gas passage and the flow which is uniformly distributed cannot be regulated, thus the energy cannot be utilized efficiently and the efficiency is low;
3. when the cluster down-the-hole hammer rotates to drill, the peripheral speed at the outer sides of the impact drill bits on the peripherally-arranged small-diameter impactors is different from that at the inner sides, thus resulting in different acting and different abrasion at the hard alloy heads distributed on the impact drill bits. The hard alloy heads at the outer sides are abraded more rapidly than those at the inner sides, thus resulting in working unbalance and relatively short service life of the whole cluster down-the-hole hammer;
4. similarly, because the cluster down-the-hole hammer has a large diameter with heavy weight, the cluster down-the-hole hammer which needs to be rotated integrally and tightened by a very large torque to reach the required tightness, is installed and disassembled on site inconveniently;
5. when the outer sides of the impact drill bits are abraded, all the peripherally-arranged small-diameter impactors need to be disassembled, rotated for 180 degrees and then reinstalled. By doing so, al-

though the problem of unbalanced abrasion can be solved, the onsite installation and disassembly are inconvenient and the construction progress will be influenced.

Summary of the Invention

[0007] The disclosure aims at providing a combined down-the-hole hammer to solve at least one of the above problems in the prior art.

[0008] The disclosure provides a combined down-the-hole hammer, comprising a coupler configured to connect with a drill rod and internally provided with a first gas passage; a bracket; and a plurality of impactors installed on the bracket, each of which is provided with a second gas passage and the impact drill bit of each of the impactors can rotate around the axis per se. A gas distributor is provided between the coupler and the bracket. The gas distributor is provided with a gas collection chamber communicated with the first gas passage and a plurality of gas-distributing paths communicating the gas collection chamber with the second gas passage of each of the impactors.

[0009] Further, the impactor comprises: an impactor main body installed in the interior of the bracket, the impactor main body is internally provided with a piston cavity for installing an impact piston; and the impact drill bit installed at the lower end of the piston cavity, the impact drill bit is matched with the impactor main body and is movable axially and rotatable circumferentially.

[0010] Further, the impact drill bit comprises an impact head and a guiding axis connected with each other; the upper portion of the guiding axis is provided with a limiting concave portion extending axially; a limiting ring is sleeved around the limiting concave portion; the guiding axis is inserted into the piston cavity and the limiting ring is limited by a locating platform provided on the inner wall of the piston cavity and a guiding sleeve installed at the lower port of the piston cavity; the guiding sleeve is sleeved on the guiding axis.

[0011] Further, the axis of at least one second gas passage of the impactors is parallel to the axis of the first gas passage; among the gas-distributing paths, the axis of the gas-distributing path which communicates at least one second gas passage and the gas collection chamber is a curve in smooth transition.

[0012] Further, a gas flow regulator is provided on at least one of the gas-distributing paths.

[0013] Further, each of the gas-distributing paths is respectively connected with the top of the corresponding second gas passage through a convergent transition gas hole, and the gas flow distributor is a damper regulating ring provided at each transition gas hole.

[0014] Further, the coupler comprises a columnar connector which forms the first gas passage. The drill rod is provided with an installation hole matched with the columnar connector. The columnar connector and the drill rod are connected by a pin shaft running therebetween.

A sealing structure is provided between the columnar connector and the installation hole.

[0015] Further, there are at least two pin shafts being provided; a rotation stopping platform surface is formed on the outer side wall of the columnar connector and the columnar connector is provided with a first cavity extending horizontally on the outer side wall thereof; the drill rod is provided with a second cavity extending horizontally and intersected with the installation hole. The pin shafts are installed in the second cavity and pass through the first cavity.

[0016] Further, the bracket comprises a cylindrical shell, an upper board connected to the upper portion of the cylindrical shell, and a bottom board connected to the lower portion of the cylindrical shell. Both the upper board and the bottom board are provided with a locating hole for installing each of the impactors; the impactor is provided with a columnar joint at its upper end and the columnar joint is provided with an inner hole forming a portion of the second gas passage. The inner hole is connected with the gas-distributing path. The columnar joint is provided with a locating circular groove at the periphery thereof. The columnar joint runs through a locating hole of the upper board and is located by a locating ring sleeved on the locating circular groove.

[0017] Further, the locating circular ring is locating ring opened oppositely, and the locating ring is sleeved with limiting sleeves, the upperside of the limiting sleeves (62) is limited by a retainer ring and a snap spring.

[0018] Further, the columnar joint is provided peripherally with a seal groove located above the locating circular groove.

[0019] Further, each of the impactors is matched with the bottom board through a key groove and a connecting key; a dustproof sealing structure is provided between the bottom board and the impactor; the upper port of the cylindrical shell is hermetically matched with the lower end face of the gas distributor, and a transition plate with a hole is provided between the lower end face of the gas distributor and the upper board.

[0020] The combined down-the-hole hammer applying the technical solution above and the construction method thereof have the following positive effect and advantages:

1. the combined down-the-hole hammer consisting of several small-diameter impactors is rational in structure, manufactured with simple processes and low cost, and easy to maintain;
2. when the combined down-the-hole hammer is driven by the power head to rotate and drill, the impact drill bit of each of the impactors can also rotate around the axis per se while revolving with the impactor, so that the hard alloy head on the impact drill bit is abraded uniformly. Therefore, the working efficiency can be improved and the service life can be prolonged;
3. among the plurality of gas-distributing paths, the

axis of the gas-distributing path which communicates at least one of the second gas passages and the gas collection chamber is a curve in smooth transition so that the compressed air transmitted to the second gas passage of each of the impactors on the periphery has little loss and high efficiency;

4. the gas flow regulator in the gas collection chamber of the combined down-the-hole hammer can be regulated to a set value according to the output rotating speed of the power head of the drill and the parameters of the gas supply system of the drill so that flows entering the impactors can be distributed reasonably, thus utilizing the energy efficiently and improving the drilling efficiency;

5. the combined down-the-hole hammer and the drill rod are connected by a columnar connector and fixedly spliced by pin shafts and sealing rings, which facilitates installation and disassembly and improves the gas passage seal reliability.

Brief Description of the Drawings

[0021] Drawings, which form a part of the description and are provided for further understanding of the present invention, show the preferred embodiments of the present invention, and explain the principle of the present invention together with the description. In the drawings:

Fig. 1 exemplarily shows a structure viewed from the front of the first embodiment of the disclosure;

Fig. 2 exemplarily shows a section structure viewed from the front of the first embodiment of the disclosure;

Fig. 3 exemplarily shows a structure viewed from above of the first embodiment of the disclosure;

Fig. 4 exemplarily shows a structure viewed from bottom of the first embodiment of the disclosure;

Fig. 5 exemplarily shows a connecting structure of the first embodiment of the disclosure and a drill rod;

Fig. 6 exemplarily shows a connecting structure of the first embodiment of the disclosure and a screw drill rod;

Fig. 7 exemplarily shows a section structure viewed from the front of the second embodiment of the disclosure;

Fig. 8 exemplarily shows a structure viewed from bottom of the second embodiment of the disclosure;

Fig. 9 exemplarily shows an impactor viewed from the front of the second embodiment of the disclosure;

Fig. 10 to Fig. 15 exemplarily show the working flow-charts of a combined down-the-hole hammer according to the disclosure;

Fig. 16 shows a structure of a down-the-hole hammer in the prior art; and

Fig. 17 shows a structure of a combined down-the-hole hammer viewed from the front and viewed in the G direction in the prior art.

Detailed Description of the Embodiments

[0022] The embodiments of the present invention will be described in detail below with reference to drawings, however the present invention may be implemented by various different ways defined and covered by the claims. In the drawings, identical components are indicated by identical reference number.

[0023] Fig. 1 to Fig. 6 illustrate the first preferred embodiment of a combined down-the-hole hammer according to the disclosure.

[0024] As shown in Fig. 1, the combined down-the-hole hammer comprises a coupler 1, a gas distributor 2, a bracket 3 and impactors 4. In combination and with reference to Fig. 2, the coupler 1 is used to connect with a drill rod 5 and is internally provided with a first gas passage 10. The first gas passage 10 is connected with a gas passage of the drill rod 5. The gas distributor 2 is provided between the coupler 1 and the bracket 3. Plurality of impactors 4 are installed on the bracket 3 and each of the impactors 4 is individually provided with a second gas passage 40. The impactor 4 comprises an impactor main body 42 and an impact drill bit 45. The impact drill bit 45 is provided with a hard alloy head 44. It can be seen from the figure that the gas distributor 2 comprises a gas collection chamber 21 communicated with the first gas passage 10 and several gas-distributing paths 22 communicating the gas collection chamber 21 with the second gas passage 40 of each of the impactors 4. The coupler 1, the gas distributor 2 and the bracket 3 may be connected by the following method. The lower end of the coupler 1 is provided with a first flange plate 12 which is connected with the upper end of the gas distributor 2 through a bolt 27 or a screw. The lower end of the gas distributor 2 is provided with a second flange plate 24, and the second flange plate 24 is connected with the upper end of the bracket 3 via a bolt 37 or a screw. In order to ensure the gas passage tightness, a sealing ring 25 is installed between the coupler 1 and the gas distributor 2.

[0025] It can be easily seen from Fig. 2 that in the present embodiment, there are 5 impactors 4, one of which is provided in the center and the other four are arranged around the central impactor uniformly in an annular manner. The second gas passage of the central impactor 4 is overlapped with the axis of the first gas passage 10, and the axes of the second gas passages of the other impactors 4 are parallel to the axis of the first gas passage 10. The gas-distributing path communicating the second gas passage in the center and the collection chamber 21 is a through structure and the axis of the gas-distributing path 22 connecting the four peripheral second gas passages and the collection chamber 21 is a curve in smooth transition, i.e. a large curvature gas passage structure, thus efficiently reducing the loss caused during the process in which the compressed air is divided to the four peripheral second gas passages and solving the problem of great pressure loss and low

efficiency caused by an almost-rectangular corner of a transverse gas passage and the gas passage of each peripheral impactor when a cluster down-the-hole hammer in the prior art divides flows to peripheral impactors and compressed air enters the gas passage of each of the impactors via the transverse gas passage. Therefore, the pressure loss of the compressed air transmitted to the second gas passage of each peripheral impactor is little and the construction efficiency of the down-the-hole hammer is improved.

[0026] It can be also seen from Fig. 2 that the central gas-distributing path 22 is further provided with a gas flow regulator 26 capable of controlling and regulating the gas supply parameters (including the gas pressure and the gas flow) of the central impactor to effectively improve the utilization efficiency of the compressed air and save the energy.

[0027] With reference to Fig. 1, Fig. 2 and Fig. 3, the coupler 1 further comprises a columnar connector 11 forming the first gas passage. An installation hole 51 matched with the columnar connector is provided on the drill rod 5. The columnar connector 11 and the drill rod 5 are connected by a pin shaft 13 running therebetween. A sealing structure 14 is provided between the columnar connector 11 and the installation hole 51 so as to install and disassemble the combined down-the-hole hammer and the drill rod 5 conveniently and seal the gas passages reliably, thus overcoming the problems in the prior art that the whole down-the-hole hammer which is connected with the drill rod 5 by a conic thread joint needs to be rotated during the connection and tightened by a very large torque to ensure the tightness between the down-the-hole hammer and the drill rod, and that the onsite installation and disassembly are inconvenient etc. Preferably, the sealing structure 14 is a sealing ring provided at the upper end of the columnar connector 11 and the edge of the upper end of the columnar connector 11 is a chamfered structure so that the gas passage sealing effect is better and the cost is relatively low.

[0028] Preferably, there are at least two pin shafts 13. In the present embodiment, there are two pin shafts 13 provided symmetrically on the same horizontal plane. Preferably, the cross section of the columnar connector 11 is a regular hexagon. Correspondingly, the installation hole 51 is an internal hexagonal hole. A rotation-stopping platform surface for preventing the columnar connector from rotating relative to the drill rod 5 is formed on each side surface of the columnar connector 11. The outer side wall of the columnar connector 11 is provided with a first cavity extending horizontally. The drill rod 5 is provided with a second cavity extending horizontally and intersected with the installation hole 51. The pin shafts 13 are installed in the second cavity and run through the first cavity to connect the columnar connector 11 and the drill rod 5 and facilitate machining of the installation hole of the pin shafts 13.

[0029] Preferably, it can be also seen from Fig. 2 that the bracket 3 comprises a cylindrical shell 36, an upper

board 35 connected to the upper portion of the cylindrical shell 36 and a bottom board 34 connected to the lower portion of the cylindrical shell 36. Both the upper board 35 and the bottom board 34 are provided with a locating hole for installing each of the impactors 4. The upper end of the impactor 4 (i.e. the upper end of the impactor main body 42) is provided with a columnar joint 41 and the columnar joint 41 is provided with an inner hole forming a portion of the second gas passage. The inner hole is connected with the gas-distributing path 22. The columnar joint 41 is provided peripherally with a locating circular groove. The columnar joint 41 runs through a locating hole 35 of the upper board and is located by a locating ring 61 sleeved on the locating circular groove. To ensure the gas tightness of the gas passage, the end of the columnar joint 41 is installed with a sealing ring 9.

[0030] Preferably, the upper port of the cylindrical shell 36 is hermetically matched with the lower end face of the gas distributor 2, and a transition plate 31 with a hole is provided between the lower end face of the gas distributor 2 and the upper board 35. The locating ring 61 is located in the hole on the transition plate 31 to enhance the structural stability of the combined down-the-hole hammer. Preferably, each of the impactors 4 is matched with the bottom board 34 through a key groove 32 and a connecting key 43. Preferably, a dustproof sealing structure 33 is provided between the bottom board 34 and the impactor 4. The dustproof sealing structure 33 is a dustproof ring extending into the locating hole of the bottom board 34, for example.

[0031] Fig. 7 to Fig. 9 show the second preferred embodiment of the disclosure. The difference between the second preferred embodiment and the first preferred embodiment above is that there are six impactors 4. The axis of the second gas passages 40 of the six impactors 4 are all parallel with the first gas passage 10. The gas-distributing path 22 connecting the collection chamber 21 with the second gas passage 40 of each of the impactors is a large curvature gas passage structure.

[0032] Preferably, as shown in Fig. 7, each gas-distributing path 22 is respectively connected with the top of the corresponding second gas passage 40 through a convergent transition gas hole 20, and the gas flow distributor 26 is a damper regulating ring provided at each transition gas hole 20. During actual application, damper regulating rings of different specifications can be selected as the gas flow distributor 26 of each corresponding gas-distributing path 22 according to the working pressure of each of the impactors 4 to distribute gas flows reasonably, utilize the energy efficiently and further improve the drilling efficiency.

[0033] With reference to Fig. 9, the impactor 4 comprises an impactor main body 42 and the impact drill bit 45. The impactor main body 42 is installed in the bracket 3 and the impactor main body 42 is internally provided with a piston cavity for installing an impact piston 410. The impact drill bit 45 is installed in the piston cavity from the lower end, and the impact drill bit 45 and the impactor

main body 42 can be matched in an axial moving manner or a circumferential rotating manner. In this way, when the power head drives the combined down-the-hole hammer to drill, the impact drill bit 45 of each of the impactors 4 can rotate around the axis per se while revolving with the impactor so that the hard alloy head 44 on the impact drill bit 45 is abraded uniformly to improve the working efficiency and prolong the service life.

[0034] Specifically, the impact drill bit 45 comprises an impact head 451 a guiding axis 49 connected with each other. The hard alloy head 44 is installed on the impact head 451. The upper portion of the guiding axis 49 is provided with a limiting concave portion 401 extending axially. A limiting ring 48 is sleeved on the limiting concave portion 401. The guiding axis 49 is inserted into the piston cavity from the lower end and the limiting ring 48 is limited by a locating platform provided on the inner wall of the piston cavity and a guiding sleeve 47 installed at the lower port of the piston cavity. The guiding sleeve 47 is sleeved on the guiding axis 49. Preferably, the limiting ring 48 comprises limiting rings opened oppositely.

[0035] Preferably, in the present embodiment, the locating ring 61 installed in the locating circular groove 411 of the columnar joint 41 is locating ring opened oppositely. Limiting sleeves 62 are further sleeved out of the limiting rings 61 and the upperside of the limiting sleeves 62 are limited by a retainer ring 63 and a snap spring 64. Preferably, the columnar joint 41 is provided peripherally with a seal groove 412 and the seal groove 412 is located above the locating circular groove 410 to ensure that gas passage tightness.

[0036] A construction method of a combined down-the-hole hammer according to the disclosure will be illustrated below in combination with Fig. 10 to Fig. 15.

1. a drill provided with a power head 7, a gas supply system 8 and a drill rod 5 travels to a construction position, and the combined down-the-hole hammer 100 and the drill rod 5 are spliced fixedly and kept sealed by two pin shafts 13 and a sealing ring 14 (see Fig. 10);
2. the power head 7 of the drill is started to drive the drill rod 5 and the combined down-the-hole hammer 100 to rotate clockwise. After the hole positions are aligned, the gas supply system 8 is started to provide compressed air to drive each of the impactors 4 of the combined down-the-hole hammer 100 to act; the drill rod 7 descends to drive the combined down-the-hole hammer 100 to rotate while performing impact drilling downwards frequently. The impact drill bit 45 of each of the impactors 4 can rotate per se while performing revolution and the fragments are discharged via an annular gap between the drill rod 5 and the hole wall onto the ground with the discharge flows of the impactor 4 (see Fig. 11);
3. a predetermined depth is drilled and the fragments are completely discharged (see Fig. 12);
4. the power head 7 is lifted and the combined down-

the-hole hammer 100 is lifted to the ground thereupon (see Fig. 13);

5. the drill moves aside, and a steel reinforcement cage is put into the hole which is filled with concrete which is set after a period time to form an underground foundation pile (see Fig. 14 and Fig. 15);

6. the drill travels to the next construction position and the aforementioned steps are repeated (see Fig. 15).

[0037] With reference to Fig. 5 and Fig. 6, besides the hollow columnar drill rod 5, a hollow screw drill rod 5 can be also used in Step 1.

[0038] In Step 2, before fixedly splicing the combined down-the-hole hammer 100 and the columnar drill rod 5 by two pin shafts 13 and a sealing ring 14, a gas flow regulator 26 in a gas collection chamber 21 of the combined down-the-hole hammer 100 can be regulated to a set value according to the output rotating speed of the power head 7 of the drill and the parameters of the gas supply system 8 of the drill so that flows can be distributed reasonably, thus utilizing the energy efficiently and improving the drilling efficiency.

[0039] It is proven by tests that the combined down-the-hole hammer according to the disclosure is matched with a screw drill rod so as to achieve better discharge effect, higher construction efficiency and higher economical efficiency, and drill deeper holes in the condition of the same gas supply amount. The combined down-the-hole hammer is especially applicable to hard strata, especially rocks to construct large-diameter ($\phi 500$ to $\phi 800$ and diameters larger than $\phi 1000$) foundation piles efficiently.

[0040] To sum up, the disclosure provides a combined down-the-hole hammer with low cost, rational structure, easy maintenance, convenient installation and disassembly, reliable seal, efficient energy utilization and high drilling efficiency.

[0041] Above contents only describe the preferred embodiments of the present invention and are not intended to limit the present invention; for one skilled in the art, the present invention may have various modifications and changes. Any modifications, equivalent replacements and improvements made within the spirit and principle of the present invention should be included within the protection scope of the present invention.

Claims

1. A combined down-the-hole hammer, **characterized in that**, the hammer comprise:
 - a coupler (1) configured to connect with a drill rod (5) and internally provided with a first gas passage (10);
 - a bracket (3);
 - a plurality of impactors (4) installed on the brack-

- et (3), each of the impactors (3) being provided with a second gas passage (40), an impact drill bit (45) of each of the impactors (4) being rotatable around the axis per se;
 a gas distributor (2) which is provided between the coupler (1) and the bracket (3); the gas distributor (2) is provided with a gas collection chamber (21) communicated with the first gas passage (10) and a plurality of gas-distributing paths (22) communicating the gas collection chamber (21) with the second gas passage (40) of each of the impactors (3).
2. The combined down-the-hole hammer according to claim 1, **characterized in that**, the impactor (4) comprises: an impactor main body (42) installed in the interior of the bracket (3), the impactor main body (42) being internally provided with a piston cavity for installing an impact piston (410); and the impact drill bit (45) installed at the lower end of the piston cavity, the impact drill bit (45) being matched with the impactor main body (42) and being movable axially and rotatable circumferentially.
 3. The combined down-the-hole hammer according to claim 2, **characterized in that**, the impact drill bit (45) comprises an impact head (451) and a guiding axis (49) connected with each other;
 the upper portion of the guiding axis (49) is provided with a limiting concave portion (401) extending axially; a limiting ring (48) is sleeved around the limiting concave portion (401);
 the guiding axis (49) is inserted into the piston cavity and the limiting ring (48) is limited by a locating platform provided on the inner wall of the piston cavity and a guiding sleeve (47) installed at the lower port of the piston cavity;
 the guiding sleeve (47) is sleeved on the guiding axis (49).
 4. The combined down-the-hole hammer according to claim, **characterized in that**, the axis of at least one second gas passage (40) of the impactors (3) is parallel to the axis of the first gas passage (10); among the gas-distributing paths (22), the axis of the gas-distributing path which communicates at least one second gas passage and the gas collection chamber is a curve in smooth transition.
 5. The combined down-the-hole hammer according to claim 1, **characterized in that** a gas flow regulator (26) is provided on at least one of the gas-distributing paths (22).
 6. The combined down-the-hole hammer according to claim 5, **characterized in that** each of the gas-distributing paths (22) is respectively connected with the top of the corresponding second gas passage (40) through a convergent transition gas hole (20), and the gas flow distributor (26) is a damper regulating ring provided at the transition gas hole (20).
 7. The combined down-the-hole hammer according to claim 1, **characterized in that** the coupler (1) comprises a columnar connector (11) which forms the first gas passage; the drill rod (5) is provided with an installation hole (51) matched with the columnar connector; the columnar connector (11) and the drill rod (5) are connected by a pin shaft (13) running therebetween; a sealing structure (14) is provided between the columnar connector (11) and the installation hole (51).
 8. The combined down-the-hole hammer according to claim 7, **characterized in that**, there are at least two pin shafts (13) being provided; a rotation stopping platform surface is formed on the outer side wall of the columnar connector (11); the columnar connector (11) is provided with a first cavity extending horizontally on the outer side wall thereof; the drill rod (5) is provided with a second cavity extending horizontally and intersected with the installation hole (51); the pin shafts (13) are installed in the second cavity and pass through the first cavity.
 9. The combined down-the-hole hammer according to claim 1, **characterized in that**, the bracket (3) comprises a cylindrical shell (36), an upper board (35) connected to the upper portion of the cylindrical shell (36), and a bottom board (34) connected to the lower portion of the cylindrical shell (36); both the upper board (35) and the bottom board (34) are provided with a locating hole for installing each of the impactors (4);
 the impactor (4) is provided with a columnar joint (41) at its upper end and the columnar joint (41) is provided with an inner hole forming a portion of the second gas passage; the inner hole is connected with the gas-distributing path (22); the columnar joint (41) is provided with a locating circular groove (411) at the periphery thereof; the columnar joint (41) runs through a locating hole of the upper board (35) and is located by a locating ring (61) sleeved on the locating circular groove (411).
 10. The combined down-the-hole hammer according to claim 9, **characterized in that** the locating ring (61) is locating ring opened oppositely, and the locating ring (61) is sleeved with limiting sleeves (62), the upperside of the limiting sleeves (62) is limited by a retainer ring (63) and a snap spring (64).
 11. The combined down-the-hole hammer according to claim 10, **characterized in that** the columnar joint

(41) is provided peripherally with a seal groove (412) and the seal groove (412) is located above the locating circular groove (410).

12. The combined down-the-hole hammer according to claim 11, **characterized in that**,
each of the impactors (4) is matched with the bottom board (34) through a key groove (32) and a connecting key (43);
a dustproof sealing structure (33) is provided between the bottom board (34) and the impactor (4);
the upper port of the cylindrical shell (36) is hermetically matched with the lower end face of the gas distributor (2), and a transition plate (31) with a hole is provided between the lower end face of the gas distributor (2) and the upper board (35).

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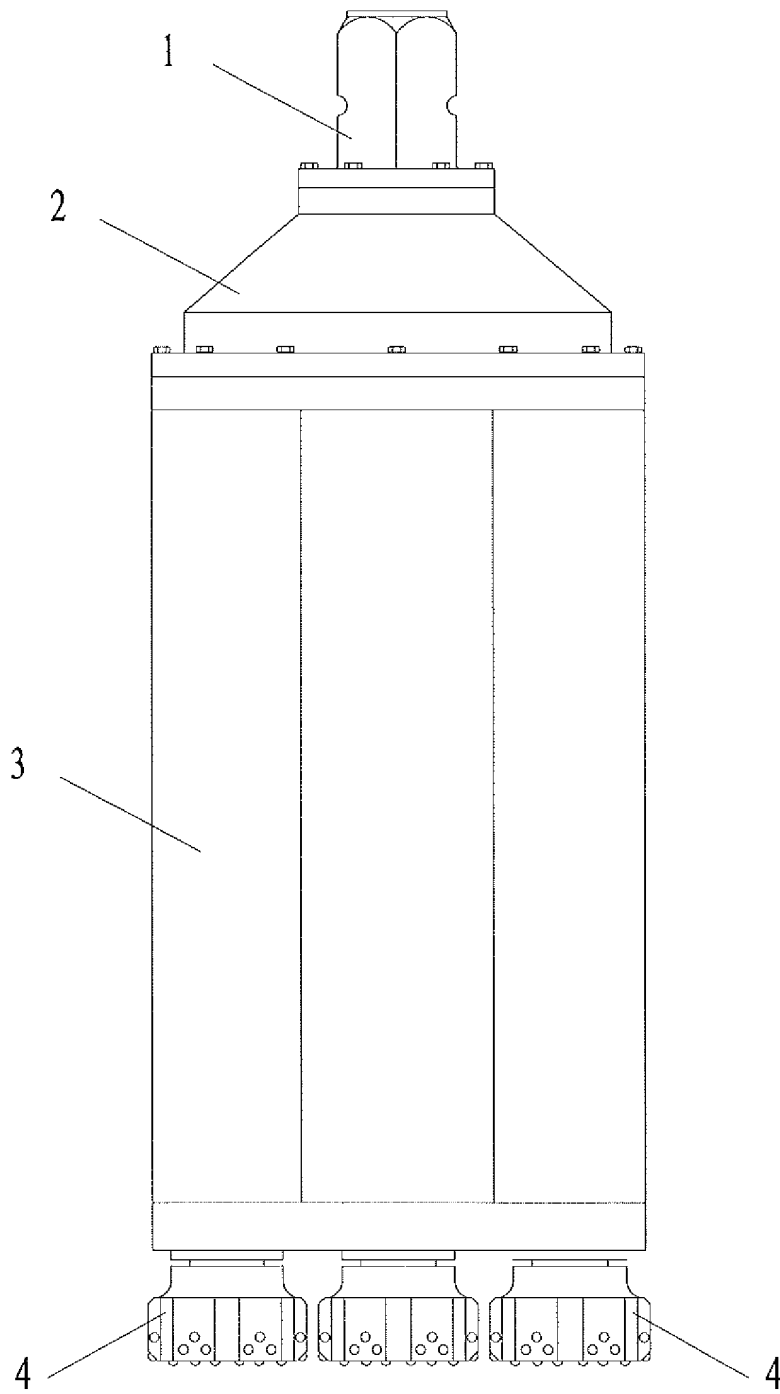


Fig. 1

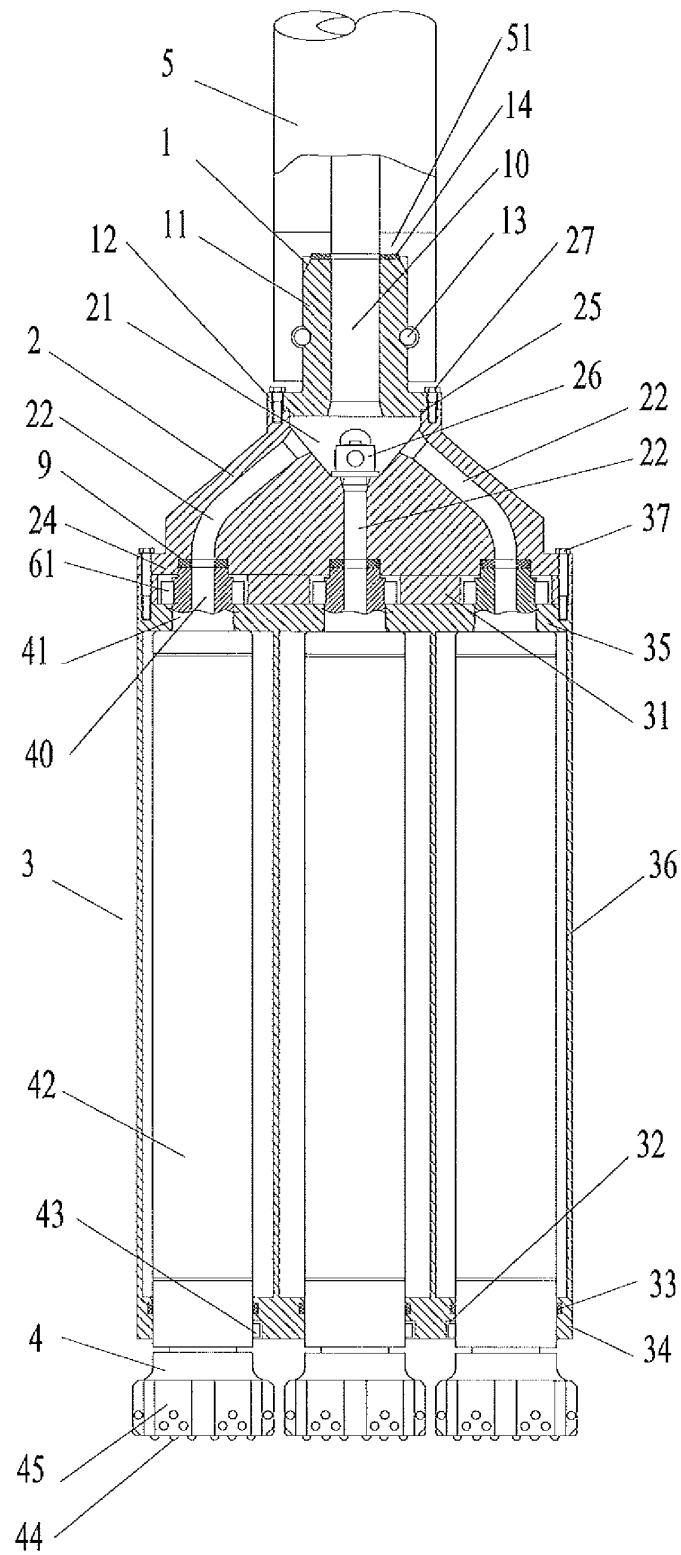


Fig. 2

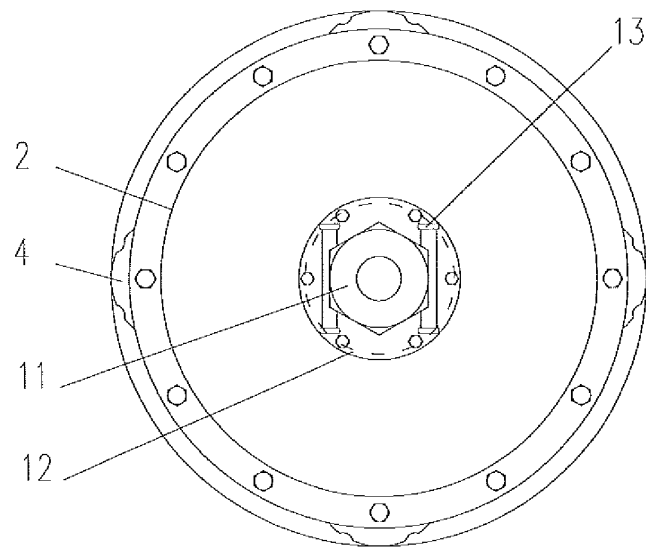


Fig. 3

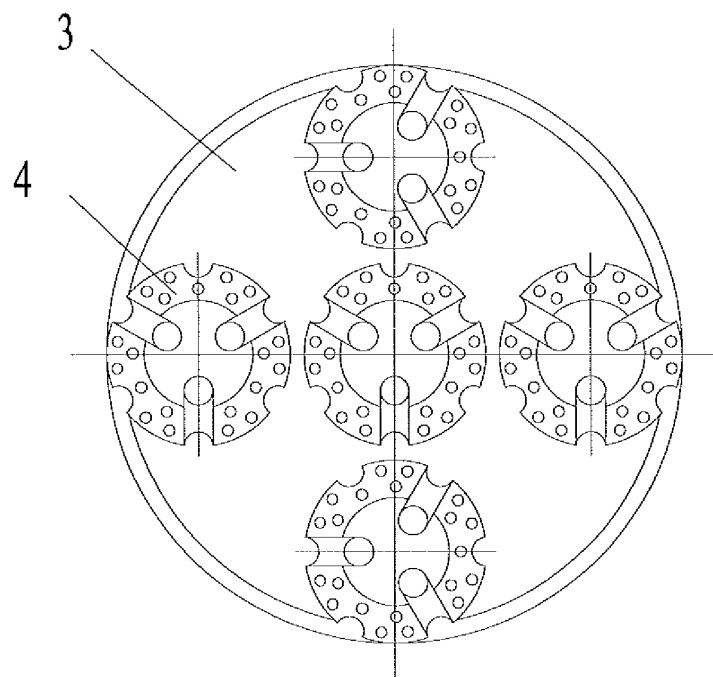


Fig. 4

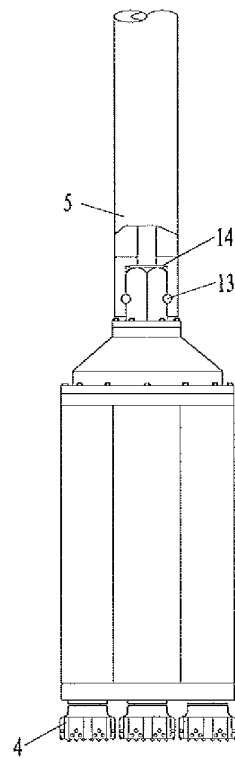


Fig. 5

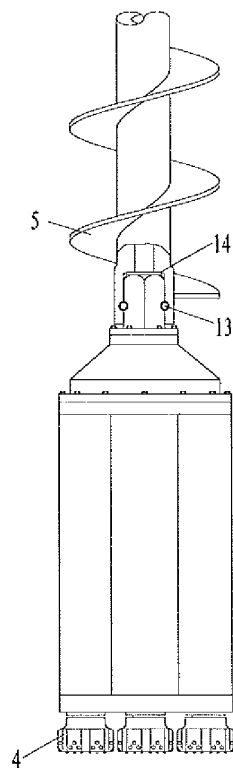


Fig. 6

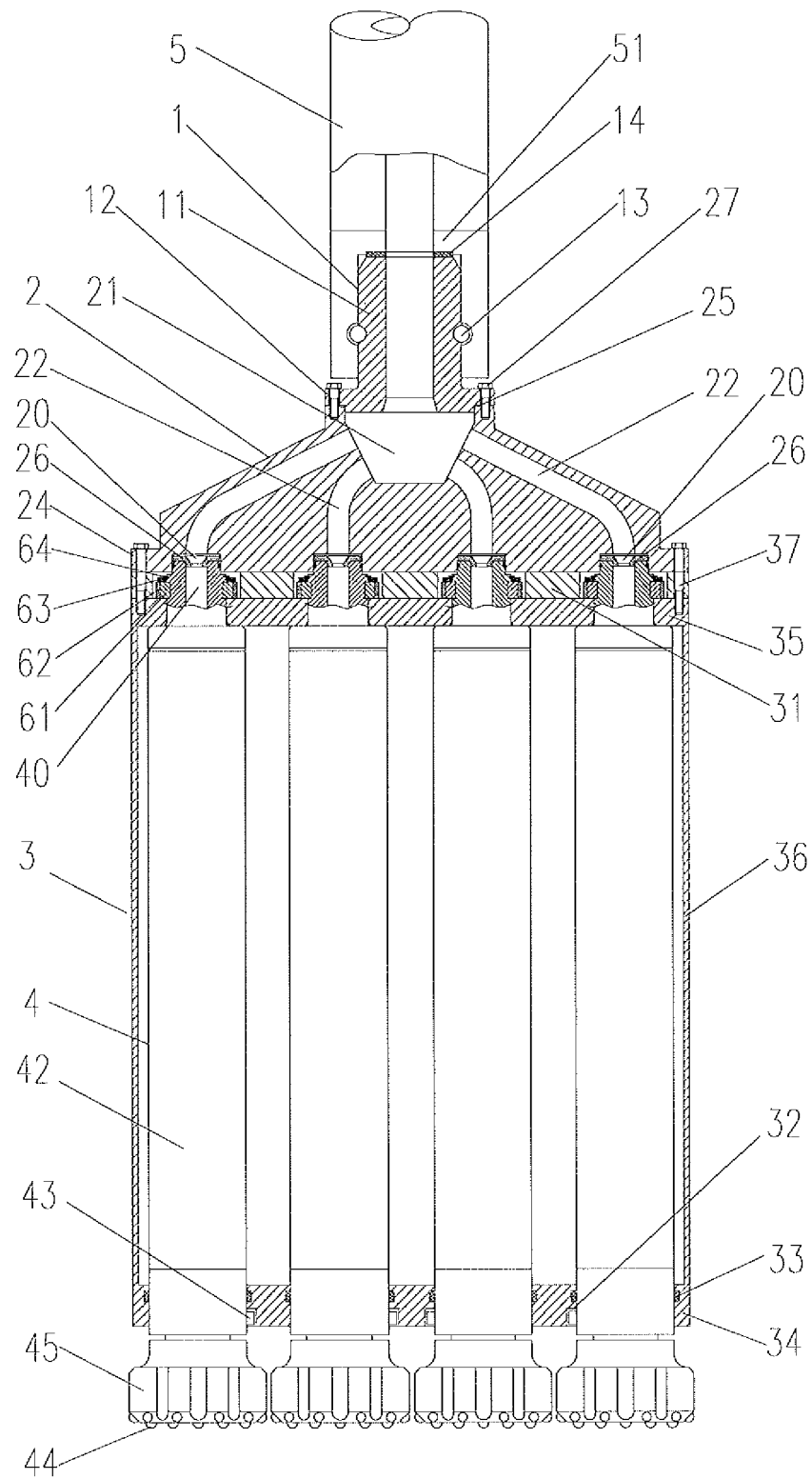


Fig. 7

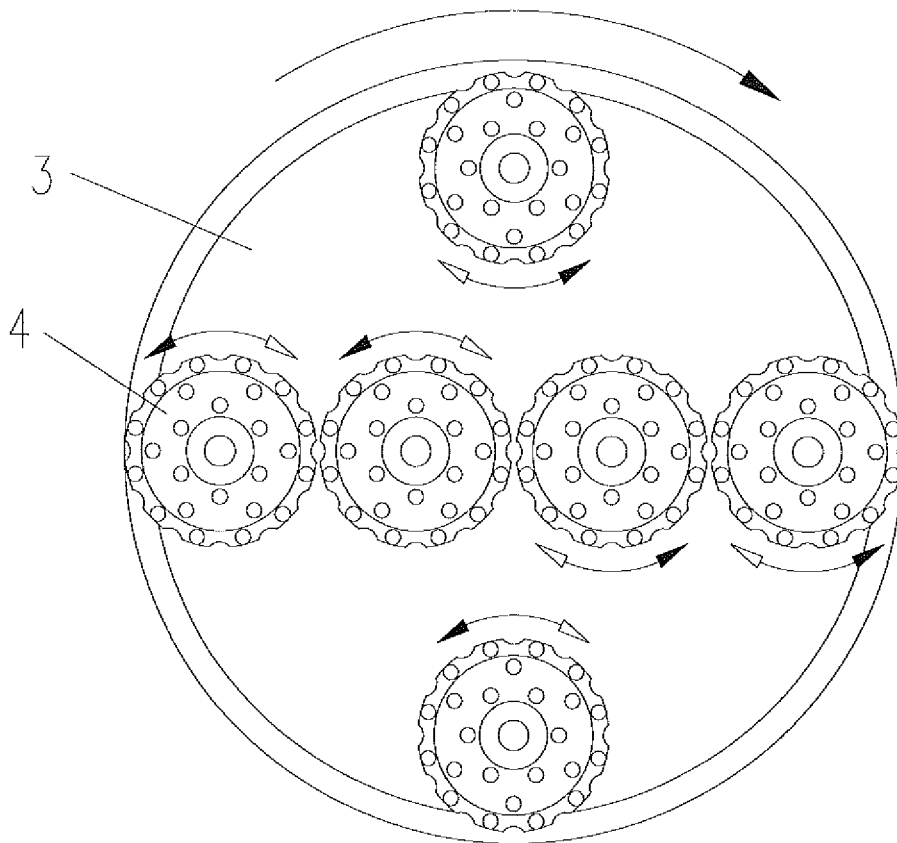


Fig. 8

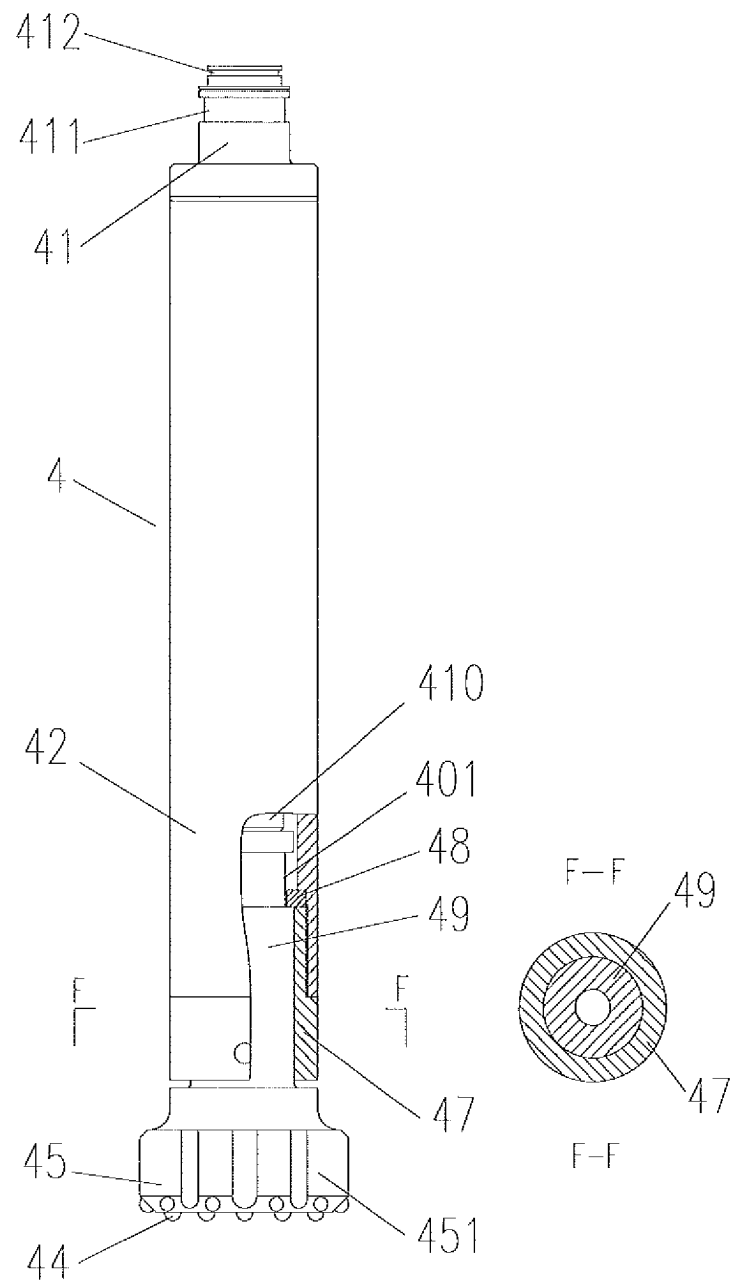


Fig. 9

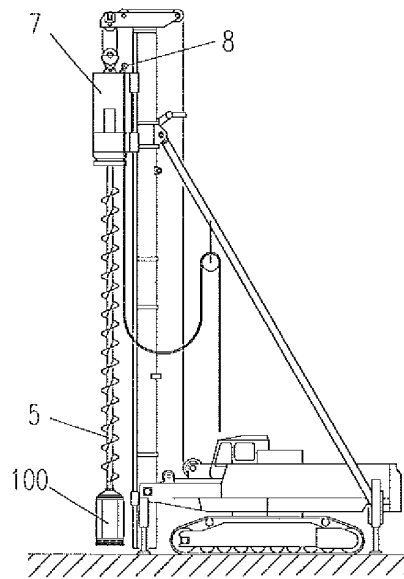


Fig. 10

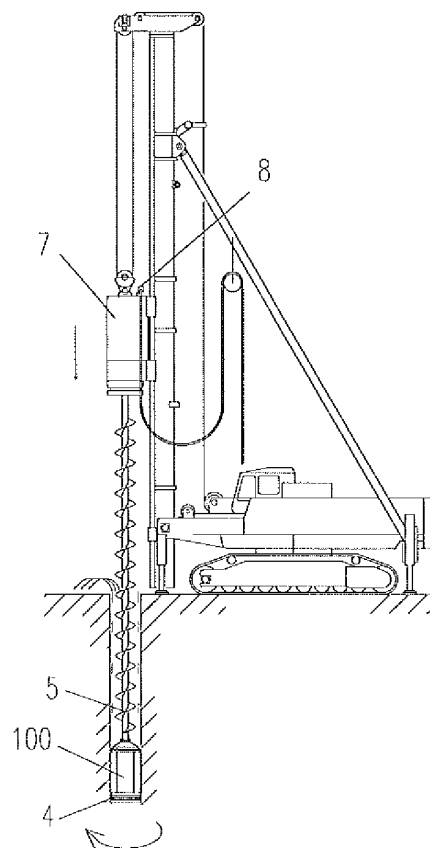


Fig. 11

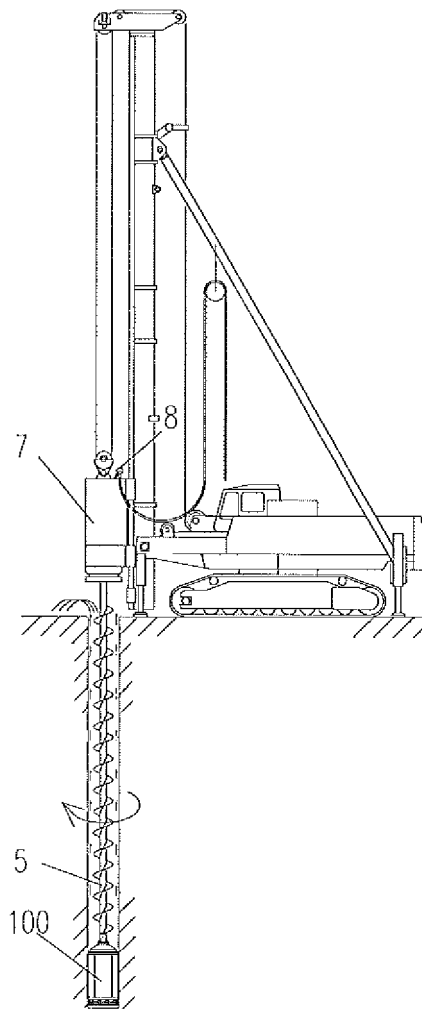


Fig. 12

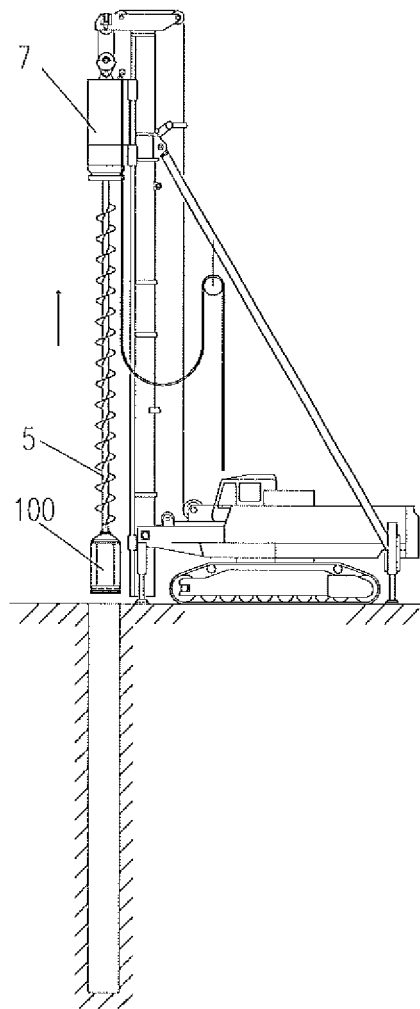


Fig. 13

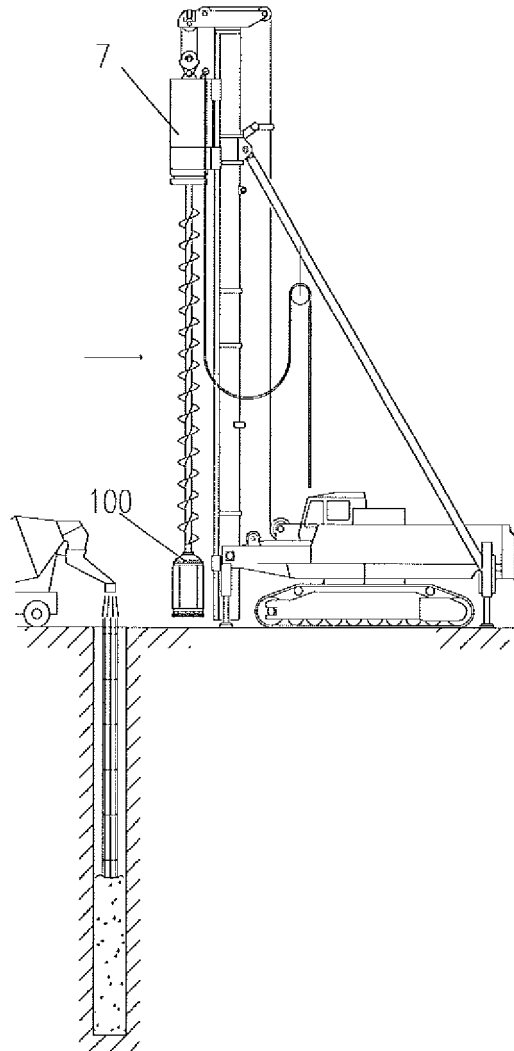


Fig. 14

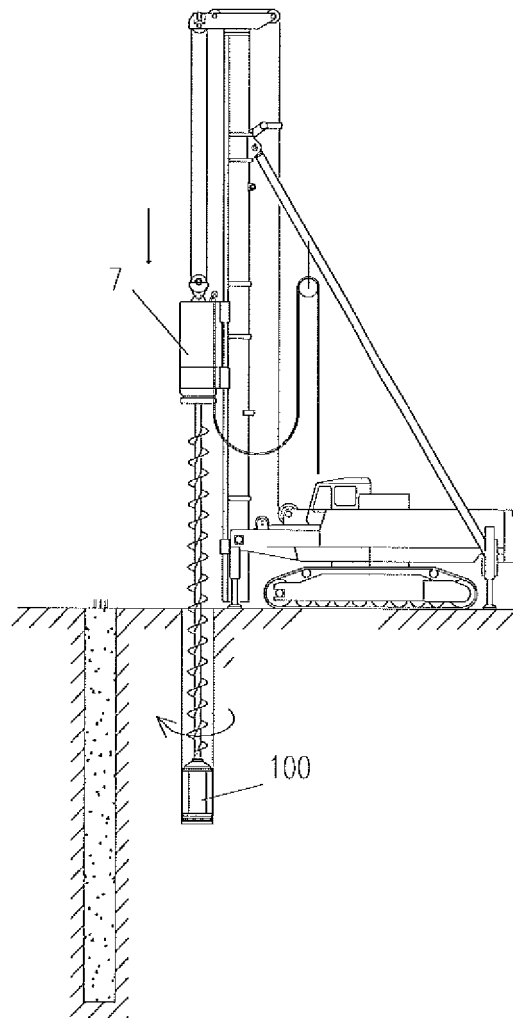


Fig. 15

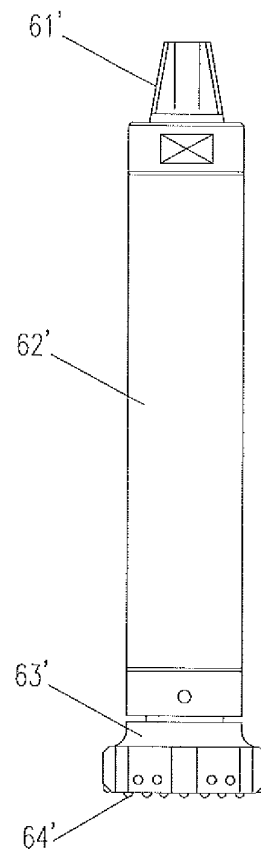


Fig. 16

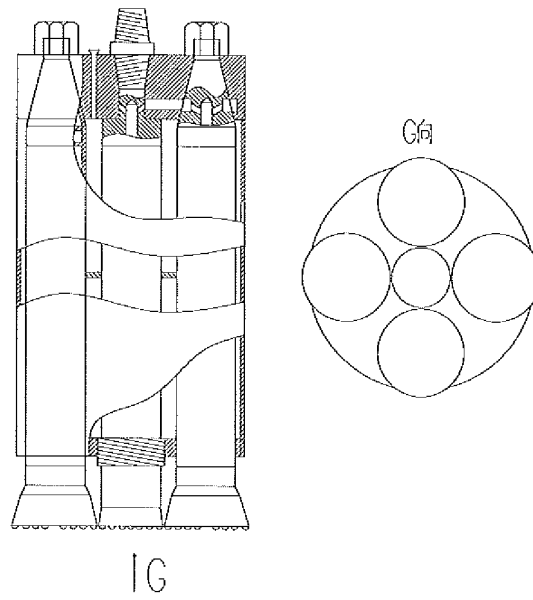


Fig. 17

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2011/076226

A. CLASSIFICATION OF SUBJECT MATTER

E21B4/06 (2006.01) i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC:E21B, E21C, E21D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNKI,CNPAT,WPI,EPODOC combined, combination, multiple, several, complex, hammer, drill, hole, bore, gas, air, fluid, distribute, allocate, assign, shunt, diverter

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP2007146446A (FURUKI KAZUNARI) 14 Jun. 2007 (14.06.2007) paragraphs 48-86 of the description, figures 1-11	1-5
Y		7-8
Y	CN201428375Y (SANY HEAVY MACHINE CO LTD) 24 Mar. 2010 (24.03.2010) figures 1-3	7-8
A	CN87104794A (INGERSOLL RAND CO) 04 May 1988 (04.05.1988) the whole document	1-12
A	SU1348478A1 (VARENIK VALERIJ A et al.) 30 Oct. 1987 (30.10.1987) the whole document	1-12

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

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"A" document defining the general state of the art which is not considered to be of particular relevance	
"E" earlier application or patent but published on or after the international filing date	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"L" document which may throw doubts on priority claim (S) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	"&" document member of the same patent family

Date of the actual completion of the international search
17 Aug.2011 (17.08.2011)Date of mailing of the international search report
15 Sep. 2011 (15.09.2011)Name and mailing address of the ISA/CN
The State Intellectual Property Office, the P.R.China
6 Xitucheng Rd., Jimen Bridge, Haidian District, Beijing, China
100088
Facsimile No. 86-10-62019451Authorized officer
CHEN, Gang
Telephone No. (86-10)62085154

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2011/076226

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US5267622A (FLETCHER GERALD L et al.) 07 Dec. 1993 (07. 12. 1993) the whole document	1-12
A	CN85102035A (WUHAN IRON & STEE) 17 Jan. 1987 (17. 01. 1987) the whole document	1-12
A	CN85204565U (TANGSHAN ENGINEERING TECHNOLOG) 29 Apr. 1987 (29. 04. 1987) the whole document	1-12

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2011/076226

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Form PCT/ISA/210 (patent family annex) (July 2009)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 4429439 A [0005]

Non-patent literature cited in the description

- China Mining Equipment Manual-Volume One. 66-68
[0003]