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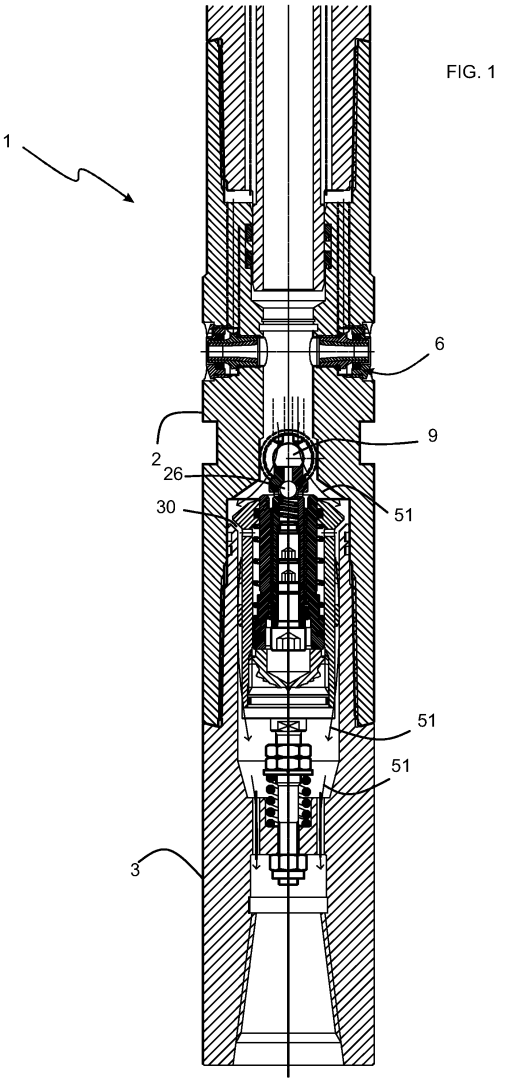
(54) Device for automatically performing ground consolidation steps of the jet grouting type

(57) The invention deals with the field of devices for performing ground consolidation steps of the Jet grouting type and more precisely refers to a device that is inserted at the end of a rod before the drilling tool in order to supply water or concrete mixture according to the consolidation process steps. The device provides for a connecting body of the drilling tool with the rod, in which first nozzles (6) and second nozzles (9) are inserted, of which the first ones are always in communication with the ground and the second ones can be clogged in certain operating steps. A valve (50) is provided, inside the body, that, according to the pressure of liquid sent to the rod, assumes three different positions, respectively for supplying water to drilling tool during a drilling step, for supplying high-pressure water to the first nozzles during a pre-cutting and crushing step, and for supplying grouting mixture to first and second nozzles for a grouting step.

FIG. 1



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Description

[0001] The present invention deals with a device for automatically performing the various steps of a ground consolidation process of the jet grouting type.

[0002] The consolidation technique of the jet grouting type provides for drilling the ground down to the desired depth and the following high-pressure injection of a grouting mixture .

[0003] In particular, the device of the present invention has been designed to be able to perform a consolidation technique that provides for:

an exploration drilling step;
a definite precutting step by injecting high-pressure water down to the desired consolidation depth to create a chamber whose volume is equal to the desired consolidation;
an injecting step of stabilising material or grouting mixture. Purpose of the device is performing the passage between one step and the other automatically depending on the pressure of liquid that is pumped in the rod.

[0004] It is clear that the tool could be also used for consolidation techniques with different steps from the described ones: for example, for particular types of ground, the exploration drilling step could be not provided for.

[0005] Object of the present invention is providing a device that contains a valve that, depending on pressures in fluids being present in the device, can assume different positions to direct said fluids in necessary areas for performing the various steps of the consolidation process.

[0006] Characteristics and advantages of the device will be better pointed out by the following description of an embodiment, shown merely as a nonlimiting example, in the attached table of drawing in which:

- figure 1 shows, in a longitudinal section, the device during the water supplying step on the drilling tool for drilling the ground;
- figures 2, 3 show the device in the same view of figure 1 respectively during two following steps in the consolidation process.

[0007] With reference to the figures, 1 designates the device that is composed of an upper nozzle-carrier body 2 and a lower body 3 incorporating a valve 50; the lower body 3 is provided with a connection 3a with tapered threading to apply a traditional drilling tool, not shown.

[0008] The upper body 2 is adapted to be screwed on its top to the traditional column 4 for drilling and supplying water or grouting mixture according to the consolidation steps, while on its bottom it provides for an internal threading 5 to which the lower body 3 is screwed.

[0009] The upper body 2 has an internal duct 7, coaxial and communicating with the rod 4, on which duct one or more first nozzles 6 are obtained, perpendicular to the duct axis.

[0010] The internal duct 7 provides for an enlargement 8 next to which one or more second nozzles 9 are placed.

[0011] The first and second nozzles communicate with the device exterior in order to allow injecting water or grouting mixture in the ground to be consolidated.

[0012] The first nozzles are always in communication with the ground, while the second nozzles can be occluded by a piston 10 slidable inside a liner 11 in turn axially slidable along a cylindrical hole 12 obtained inside the valve-carrier body 3.

[0013] The piston 10 has a chamber 13, closed on its bottom by a cover 14 equipped with a seat 15 in which a stem 16 is inserted, kept upward pressed by a lower spring 17 that abuts between a washer 18, placed along the stem through adjusting screws 19, and a transverse shoulder 20 of the valve-carrier body 3.

[0014] In the transverse shoulder 20, holes 21 are obtained that communicate the chamber 12 with the connection area of the drilling tool for supplying water to the tool itself.

[0015] The piston 10 is slidingly inserted in the chamber 13, the piston 10 being in turn provided with a chamber 22 equipped with a threading on which a fuse 25 is screwed, that comprises an adjusting screw 23 that presses on a spring 24 that operates on a ball 26 inserted in a seat 27 communicating, through a hole 28, with the enlargement 8 of the internal duct 7.

[0016] The seat 27 communicates through holes 31 with the chamber 13 when the ball 26 opens the hole 28.

[0017] The internal liner 11 has on its top a drilled, mushroom-shaped cap 29 that is adapted to a seat 30 obtained on the upper edge of the valve-carrier body 3.

[0018] The external diameter of the piston 10 is such as to allow the piston to penetrate inside the enlargement 8 in order to be able to close the nozzles 9 that end in said enlargement, as will be better shown when describing the device operation.

[0019] It must also be considered that the enlargement 8 diameter is less than the chamber 13 diameter.

[0020] In conclusion, inside the lower body 3, the valve 50 is inserted and can assume three positions:

- a first position is the one occurring between mushroom-shaped cap 29 and seat 30 obtained on the body 3 edge for supplying water to the drilling tool;
- a second position occurs between ball 26 and seat 27 for sending water to the chamber 13 for creating a counterpressure in order to keep the piston 10 pressed in the enlargement 8;
- a third position occurs between piston 10 and enlargement 8 for supplying grouting mixture also to the assembly of lower nozzles 9.

[0021] 32 and 33 designate two return springs, respectively for piston 10 and fuse 25.

[0022] The device operation will now be described.

[0023] With reference to figure 1, namely during the

simple ground drilling step, low-pressure water must be inserted, simply in order to lubricate and cool the drilling tool, not shown and connected to the lower body 3.

[0024] In this step, generally the water pressure is around 50 bar and is not such as to overcome the lower spring 17 action, that will keep the internal liner 11 upward pushed: therefore, the valve will be in the water flow-back position towards the drilling tool according to arrows 51.

[0025] The majority of water will go out towards the drilling tool.

[0026] With reference to figure 2, high-pressure water (equal to about 400-450 bar) will be supplied for performing ground cutting and crushing.

[0027] In this step, the lower spring will be compressed and the piston 10 will be moved downwards, and afterwards the water supplying valve to the drilling tool will be closed.

[0028] All water will be discharged through the first upper nozzles 6.

[0029] The nozzles 9 are closed.

[0030] High pressure will manage to overcome the spring 24 action and therefore to move the ball 26 downwards; this will allow the passage of water through the holes 31 and therefore in the chamber 13.

[0031] The water pressure in the chamber 13 will move piston 10 upwards, closing the second nozzles 9.

[0032] This is possible since the chamber 13 section is greater that the seat or enlargement 8 section, and therefore the upward thrust will be greater than the downward thrust.

[0033] The pressure in chamber 13 exerts an upward thrust on piston 10 that closes the nozzles 9.

[0034] The above-described device, depending on spring pre-calibration, is automatically adapted to the grouting steps depending on pressures exerted by injected liquids or mixtures.

[0035] With reference to figure 3 in which a grouting mixture is supplied at about 200 bars, said mixture will operate on the liner 11 mushroom keeping the liner downwards, so that all first and second nozzles will be free and be able to inject the mixture to perform the desired consolidation.

[0036] All springs must have such a calibration as to allow interventions in the three valve positions next to the three operating pressures in the three consolidation steps.

[0037] In the description, no reference has been made to sealing members such as gaskets or extrusion-preventing rings, though they have been shown, since their use is common for a skilled person in the art.

[0038] Some of the described and shown helical springs could be replaced by other types of elastic means; for example, the spring 24 that is subjected to a pressure of 400-450 bar, could be replaced by Belleville washers without departing from the scope of the below listed claims.

Claims

1. Device for automatically performing ground consolidation steps of a jet grouting type, of a type comprising a connecting body of a drilling tool to a drilling and water or grouting mixture supplying rod, **characterised in that** it comprises:

   one or more first upper nozzles (6) always in connection with the ground;
   one or more second nozzles (9) placed below the first nozzles and adapted to be clogged during a certain consolidation process step;
   a three-function valve (50):

   - for supplying water to the drilling tool;
   - for creating a counterpressure that keeps the second nozzles closed during a cutting and crushing step with high-pressure water
   - for supplying grouting mixture to the first and second nozzles.

2. Device according to claim 1, **characterised in that** the connecting body comprises an upper body (2) on which first and second nozzles (6) and (9) are obtained and a lower body (3) in which the valve (50) is inserted, said two bodies being mutually connected through screwing.

3. Device according to claim 1, **characterised in that** the first valve (50) comprises an internal liner (11) having a mushroom-shaped cap that seals on a seat (30) obtained on the upper edge of the valve-carrier body (3).

4. Device according to claim 1, **characterised in that** the valve comprises a piston (10) sliding inside a chamber (13) of the liner (11) and adapted to be inserted in a seat or enlargement (8) in which the second nozzles are opened.

5. Device according to claim 4, **characterised in that** the section of the chamber (13) is greater than the section of the seat or enlargement (8) to allow closing the second nozzles upon the fluid pressure increase.

6. Device according to claim 1, **characterised in that** the third valve comprises a ball (26) inserted in a seat (27) obtained in a fuse (25) in which a spring is inserted that can be calibrated and that presses onto said ball, said valve being inserted between the enlargement and the chamber (13) within which the piston (10) slides.

7. Device according to claims 1 and 4, **characterised in that** the closure of the second nozzles occurs with a pressure increase from 50 to 200 bars.

8. Device according to claims 1 and 3, **characterised in that** the first valve comprises a spring that keeps it normally open up to liquid pressures around 50 bars.

FIG. 1

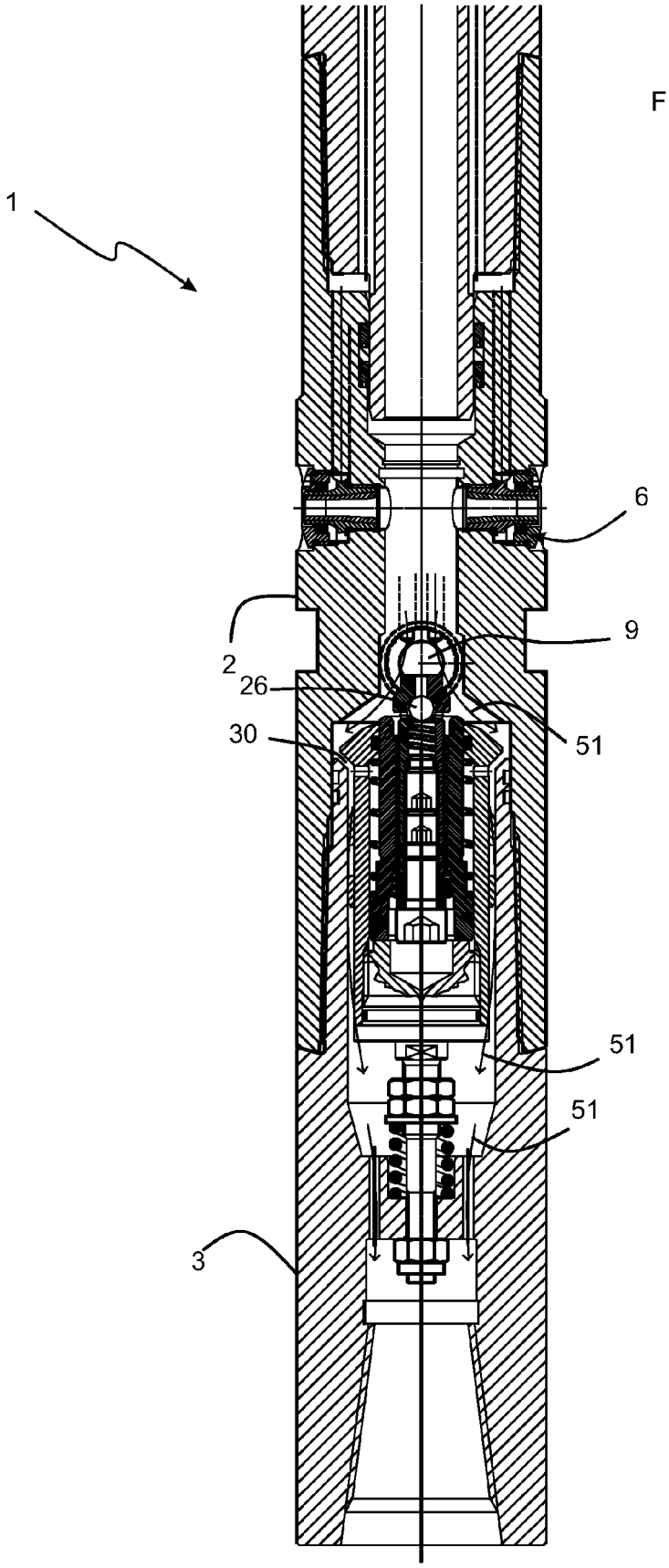
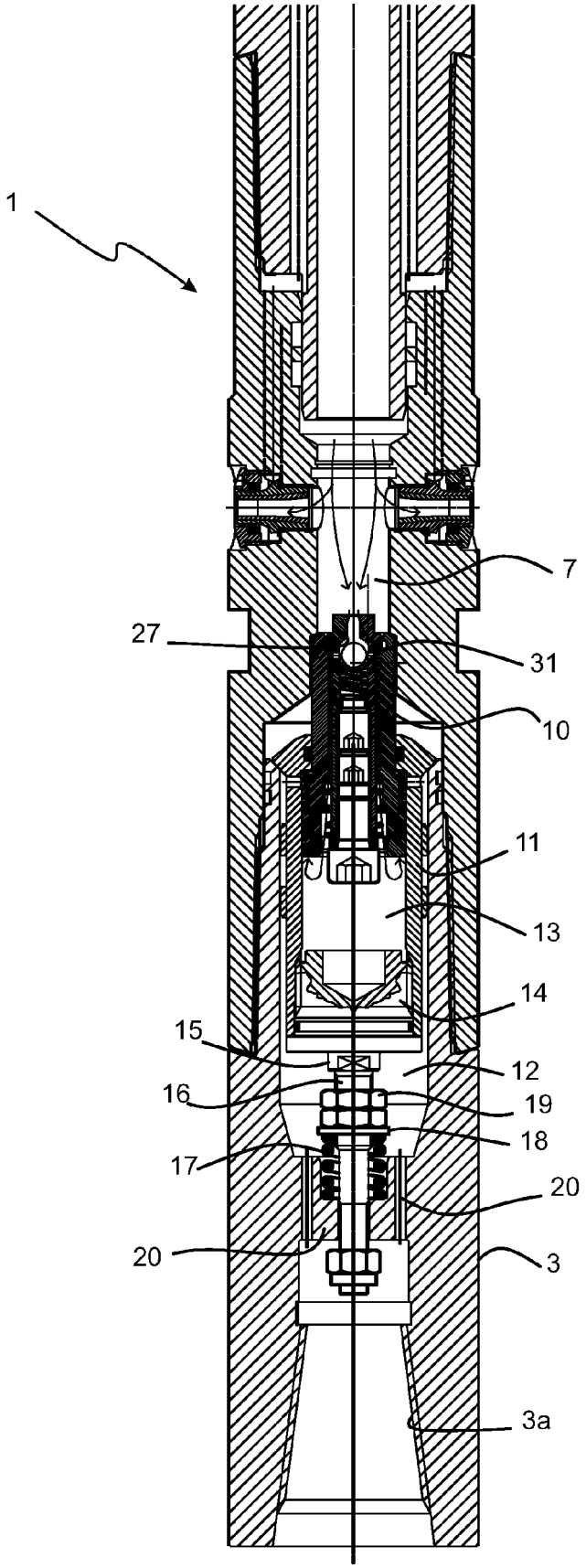


FIG. 2



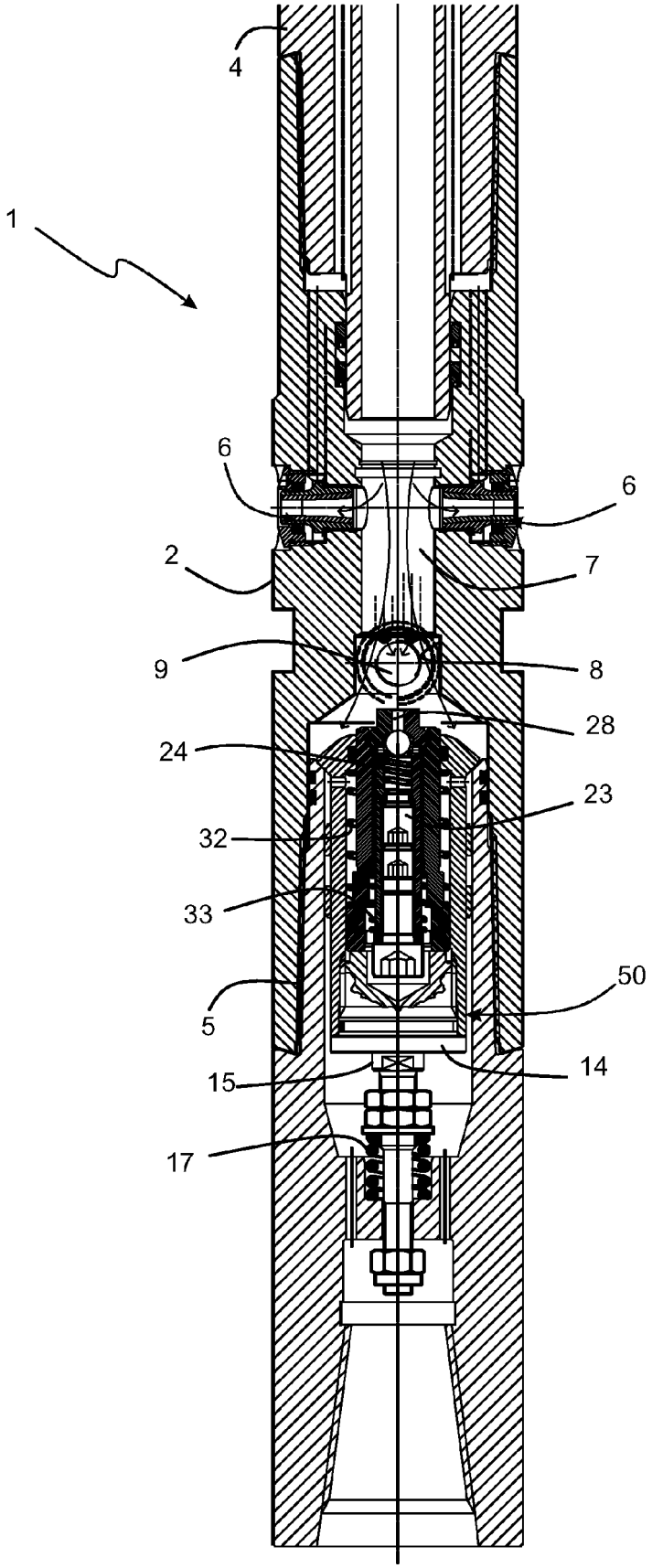


FIG. 3