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[54] **DEVICE FOR CONNECTING A DRILL BIT TO A DRILL STRING PROVIDED WITH A PENETROMETER**

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[51] **Int. Cl.** **E21b 47/00**

[58] **Field of Search**.....175/40, 50, 292, 263, 257, 175/268

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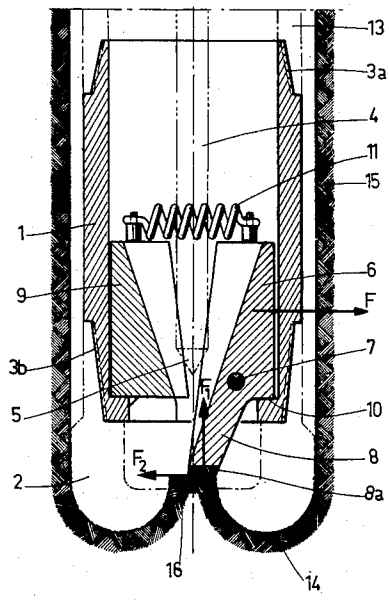
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[57] **ABSTRACT**

Device for connecting a drill bit having a central bore to a drill string having at its lower part a retractable penetrometer, comprising an obturation member for the central bore, the lower part of which is provided with cutting elements, and adapted to block said central bore in response to the centrifugal force generated by the rotation of the bit, said obturation member leaving open said bore in the absence of rotation of the bit.

7 Claims, 7 Drawing Figures



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SHEET 1 OF 4

FIG.1

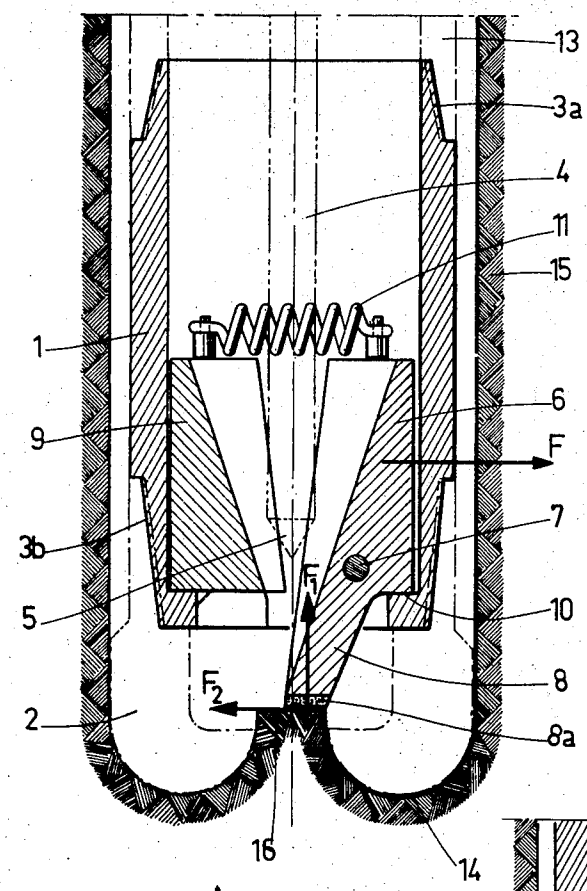


FIG.2

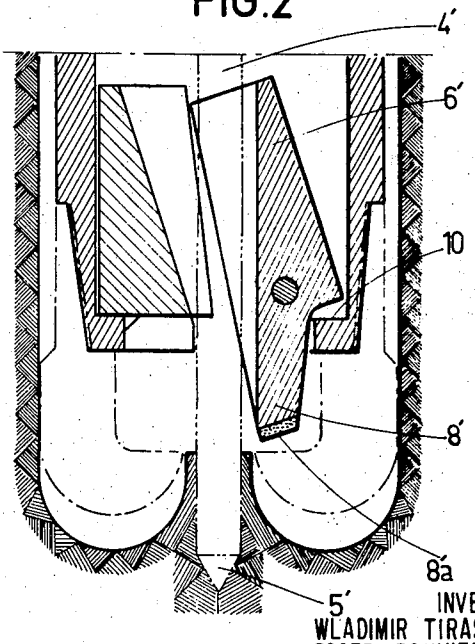
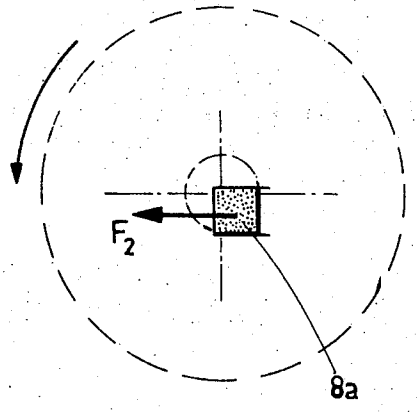


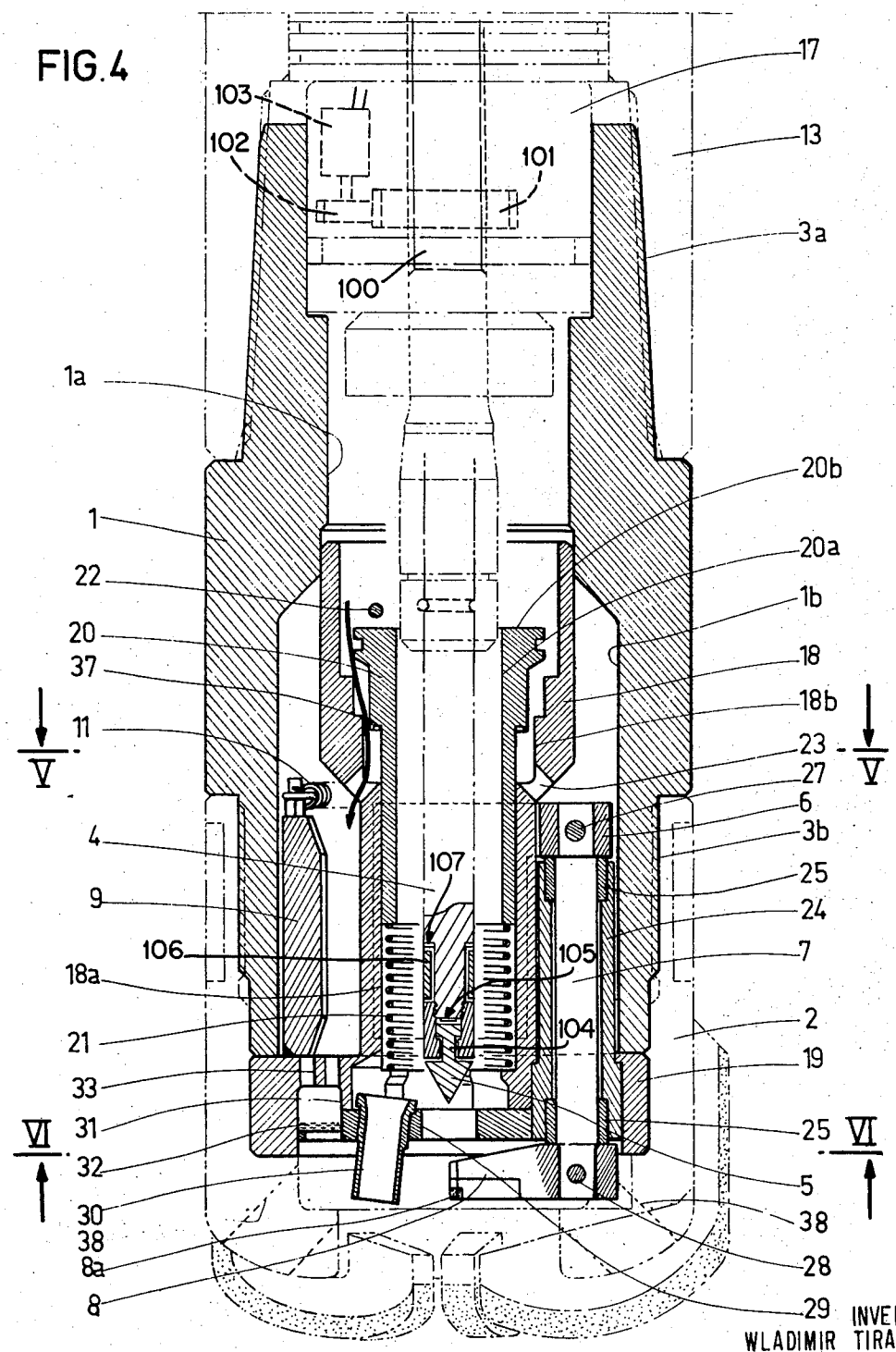
FIG.3



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FIG.4



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FIG. 5

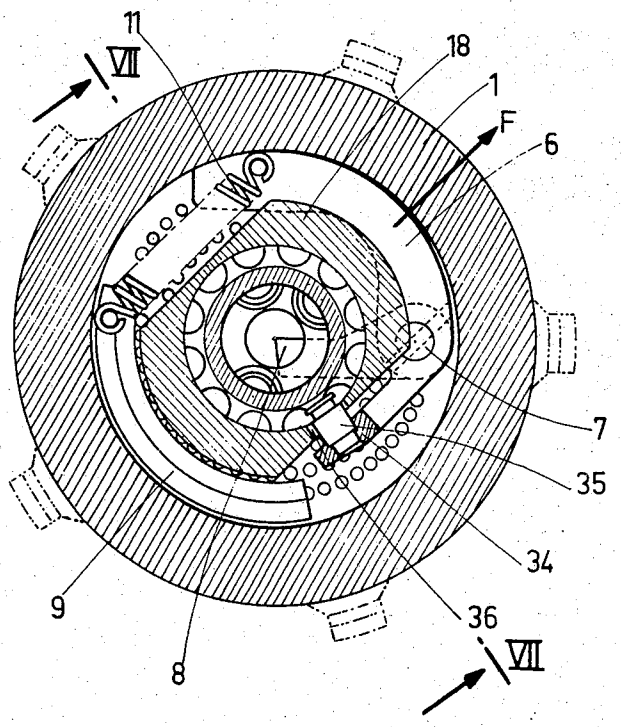
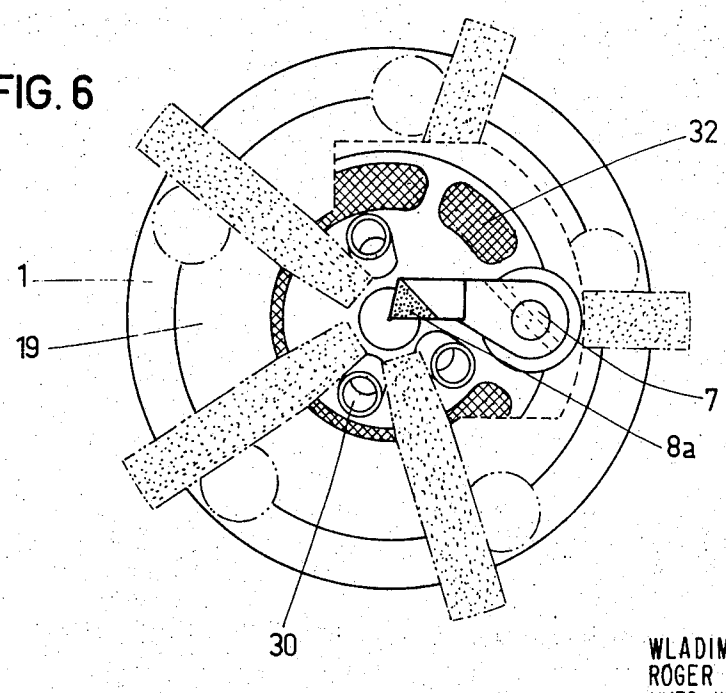


FIG. 6

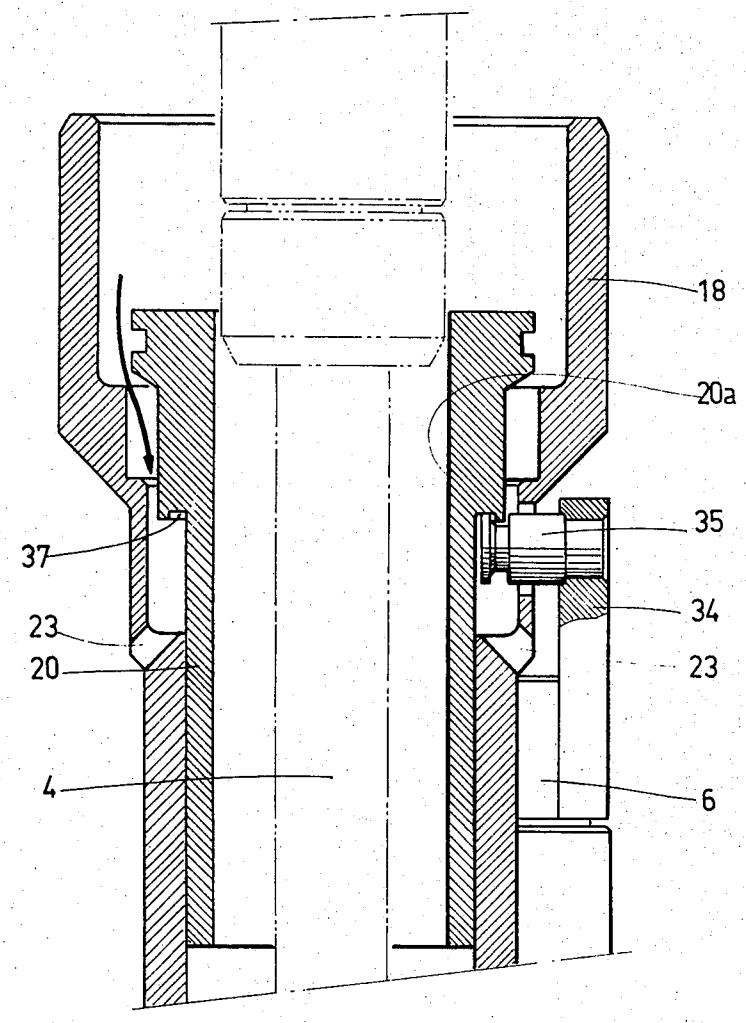


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FIG.7



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DEVICE FOR CONNECTING A DRILL BIT TO A DRILL STRING PROVIDED WITH A PENETROMETER

This invention relates to a drill bit associated to a device for measuring the mechanical characteristics of the soil and more particularly to a penetrometer; i.e., an apparatus for measuring the resistance to penetration of the soil.

Surveying operations of a ground layer on which has to be built a work, are advantageously carried out by means of the so-called penetrometer as measuring apparatus.

This apparatus includes a stem ending with a tip and comprising control means for measuring the resistance forces of the ground to the penetration of said stem at the level of the end of the tip as well as lateral friction forces.

From the measurements carried out there can be determined the mechanical characteristics of the earth formations or ground layers, said determination being necessary for example for the selection of the anchoring points on which will be fixed the works to be built.

The maximum penetration depth of the penetrometer stem being obligatorily limited, in order to effect measurements inside the ground layer on survey, there is carried out a drilling and the penetrometer is used only when the drilling attains the depth at which it is desired to effect the measurement.

It is however desirable to avoid to have to carry out at each measurement the series of operations consisting of withdrawing the drilling tool, introducing the penetrometer into the bore hole and, after the measuring step, withdrawing the penetrometer and reintroducing the drilling tool into the well.

All of these operations will in fact result in substantial and costly time losses, particularly when it is difficult to find again the bore inlet from one operation to the next, which is for example frequent in the case of submerged wells.

In order to avoid this drawback it is advantageous to incorporate the penetrometer to the lower part of the drill string itself.

Such a device including the penetrometer incorporated to the lower part of the drill string, comprises a drill bit having a central bore for the passage of the penetrometer stem, during the measuring step carried out at the selected depth and following a step of drilling at said depth.

There is arising a problem during the drilling step where the penetrometer is withdrawn inside the drill bit, which is that of destroying the central part of the forehead forming a core within the central bore of the drill bit, while still protecting the stem from any contact with the forehead.

Those skilled in the art also consider as essential to carry out these measurements in a continuous manner in a ground layer of a thickness greater than the length of the stem projecting outside the drill bit when the penetrometer is in position for measurement. The problem to be solved is that of obtaining the advance of the drill string in the well without rotation of the drill bit, while the penetrometer is in position for measurement.

One of the main objects of this invention is to provide a drill bit connection automatically ensuring the penetrometer protection during the drilling operations.

Another object is to provide a drill bit connection whereby the penetration measurements may be carried out in a continuous manner in a ground layer of a depth greater than the length of the penetrometer stem.

The device of this invention is adapted to the connection of a drill bit having a central bore, to the end of a drill string, at the lower part of which is provided an apparatus for measuring the mechanical characteristics of the ground, comprising a stem of a diameter at most equal to that of the central bore of the drill bit, provided with elements for measuring the resistance forces opposed by the ground to the stem penetration. This device may be triggered from a position for drilling, at which the stem is withdrawn inside the drill string which is then driven in rotation, to a position for measurement at which this rotation is stopped and the stem driven in the ground through the drill bit central bore, and

it comprises at least one articulated member for obturation of the drill bit central bore, provided at its lower part with means for the ground attack, said member being adapted to automatically close the drill bit central bore in response to the centrifugal force generated by the rotation of the bit, and means for the return of said member to a position where it no longer closes said bit central bore when rotation of the bit is stopped.

According to a preferred embodiment of the invention the device further comprises ducts inclined with respect to the bit axis, said ducts being provided for the drilling by jets when the bit is not driven in rotation so as to make possible a continuous measurement of the mechanical characteristics of a ground layer, a piston actuated by the pressure of a drilling fluid and adapted to permit, for a pressure of said fluid higher than a predetermined value, either the feeding of said ducts with drilling fluid for the drilling by jets when the bit is not in rotation, or, during the rotation of the bit, the locking of said obturation member and, for a value of the drilling fluid pressure lower than said predetermined value, the discharge of the drilling fluid, whereby the cuttings can be driven away from the forehead during local measurements of the mechanical characteristics of the ground layers.

Non-limitative embodiments of the invention are illustrated by way of example in the accompanying drawings wherein :

FIG. 1 shows an axial cross-section of a first embodiment of the device of the invention during the rotary drilling stage,

FIG. 2 shows the device according to this embodiment in the same cross-section during the stage of local measurement, the drill bit rotation being stopped,

FIG. 3 is a view from below of the device of FIG. 1,

FIG. 4 illustrates in axial cross-section a preferred embodiment of the invention during the rotary drilling stage,

FIG. 5 is a cross-section of the device along line V–V of FIG. 4,

FIG. 6 is a view from below of the device of FIG. 4 with a partial cross-section along line VI–VI of FIG. 4 and,

FIG. 7 is a cross-sectional view along line VII–VII of FIG. 5.

On FIG. 1, reference 1 indicates the special connector provided, at each of its ends, with a threading. The

upper threading 3*a* is adapted for fastening connector 1 to the lower end of a drill string 13, shown in mixed line, wherein is incorporated a penetrometer, the only measuring stem 4 of which is shown in mixed line at its actual position during the drilling stage. The lower threading 3*b* is adapted for fastening the drill bit 2, shown in dashed line, onto the connector 1. The drill bit 2 is of the type having a central bore of a diameter at least equal to that of the measuring stem 4 of the penetrometer.

The bit may be crown-shaped or of the type comprising radial blades with an outer surface covered for instance with a diamond concretion.

In the connector 1, a movable mass 6 is articulated about an axis 7, solid with the connector and orthogonal to the axis thereof. The movable mass 6 is extending at its lower part with a member 8 for obturation of the bit central bore, said member having an end part 8a covered with an abrasive material, for example a diamond concretion.

A stationary mass 9, made solid with the connector, for example by welding, provides for the dynamic balance thereof during its rotation.

A spring 11 connects the upper end of the movable mass 6 to the stationary mass 9.

For drilling the operation is as follows : before the contact of the bit with the forehead 14 of the well 15, the drill string 13 is driven in rotation, the measuring stem 4 of the penetrometer having the position shown in FIG. 1. As a result of the rotation of the drill string 13 the mass 6, which is then subjected to a centrifugal force F, rotates about axis 7 until it comes in abutment against the shoulder 10 of connector 1. This rotation of the mass results in a stretching of spring 11 and brings the obturation member 8 closer to the central bore of the bit to a position in line with the axis of the bit 2 or even advantageously beyond this position. The device is thus in a position for drilling (see FIG. 1).

During the drilling stage the part 8*a*, which acts as a tool, prevents the formation of a core 16 in the central part of the bit. In this part the forehead 14 then exerts on surface 8*a* of member 8 a reaction force F_1 opposed to the advance of the bit and a force F_2 due to the frictions of the forehead on the surface 8a during the bit rotation. As shown in FIG. 1 the shape of member 8 is such that forces F_1 and F_2 maintain this member in drilling position by imparting thereto a rotation moment with respect to axis 7, which has the same direction as that produced by the centrifugal force exerted on mass 6. The central bore of the bit is thus obturated by member 8 which protects the tip 5 of stem 4.

When the drilling reaches the desired depth at which a penetration measurement has to be carried out, the bit rotation is stopped. The drill string is slightly raised so as to disengage the bit from the forehead. The return spring 11 causes the mass 6 and member 8 to rotate on pivot 7 to the position shown at 6′ and 8′ in FIG. 2, so as to make free the central bore of the bit for the passage of stem 4 which takes the position shown at 4′ in FIG. 2, the stem tip being in the position 5′ during penetration into the ground.

FIG. 3 shows the position of the active surface 8*a* of member 8 during the drilling stage.

The means for driving the tip into the ground as well as the means for measuring the mechanical characteristics of the ground may be of any known type and form no part of the invention.

FIGS. 4 to 7 illustrate a preferred embodiment of the device according to the invention.

The special connector 1 is coupled through a threading 3*a* with the end of a drill string 13 wherein is housed a penetrometer 17 provided with a measuring stem 4.

The measuring rod or stem 4 is secured to the end of a threaded actuating rod 100. This actuating or manipulating rod is adapted to turn about its axis and to gluide vertically with respect to the body of the penetrometer 17. The actuating rod is provided with an internally threaded ring 101 being adapted to turn about its axis and driven in rotation by a pinion 102 which is integral with the shaft of a motor 103 subject to remote control from the surface.

When the motor 103 is actuated, the ring 101 turns and, in cooperation with the threading of the actuating rod, displaces this actuating rod vertically. Depending upon the respective direction of rotation of the motor, a displacement of the measuring rod or stem in either the downward or upward direction of the figure is brought about. A groove and pin arrangement or assembly may possibly render it possible that the measuring stem or rod not be driven in rotation by the actuating rod.

Micro-contacts (not shown) stop the motor 103 when the operating or manipulating rod has reached either its maximal upper or maximal lower position while still allowing for the control of the motor from the surface so as to cause the reverse manipulation of the rod 100, if such is necessary.

The measuring point or tip 5 which has a conical shape is extended by a rod 104 which glides within a bore of the measuring stem 4. When the penetrometer is embedded in the ground, the rod 105 acts upon a stressing gauge 105 which is interposed between the rods 4 and 105 and which allows for measuring the penetration stresses.

A ring 106 having a specific length is maintained between two shoulder portions of the manipulating or operating rod. When the latter penetrates into the ground or formations, the ring 106, due to the action of frictional forces, acts upon the stressing gauges 107 being interposed between the upper shoulder portion of the measuring rod or stem and the ring 106, which allows for measuring the frictional stresses or forces of the ground or formation on the ring 106. At its lower end the connector 1 is coupled with a drill bit 2 by means of a threading 3*b*. The bit 2 consists of a body provided with radial blades covered with a diamond concretion and leaving free, at the central part of the bit, a passage-way whose diameter is at least equal to the diameter of stem 4 of the penetrometer. A bore 1*a* is provided through the upper part of connector 1 and is extended downwardly by a bore 1*b* of greater diameter.

A tubular element 18, or drilling fluid distributing member, is housed inside the connector 1 and forms within bore 1*b* an annular space inside the connector.

This member 18 is provided at its lower end with an annular shoulder 19 taking its bearing on the lower end of connector 1 so as to be fixed in position by the fastening of the bit onto the connector 1.

A piston **20** is slidably mounted in the bore **18**a of member **18**. A spring **21** interposed between the lower end of piston **20** and an internal annular shoulder of member **18** urges upwardly the piston **20** whose vertical displacement is limited in this direction by a stop member **22** solid with member **18**.

A central duct **20***a* of piston **20** gives passage to the stem **4** of penetrometer **17**. In the bore **1***b* of connector **1** the member **18** is provided with inclined orifices **23** through which bore **18***b* of member **18** communicates with bore **1***b* of connector **1**.

On shoulder **19** is secured a bearing **24** provided with a bush **25** in which is rotatably mounted a shaft **7** parallel to the connector axis. At its upper part, the shaft **7** is made solid with a movable mass **6** by means of a joining pin **27** whereas at the lower end of shaft **7** a joining pin **28** locks an obturation member **8** in a position perpendicular to shaft **7**. In the central part of shoulder **19** is provided an orifice **29** leaving passage to the stem **4** of the penetrometer with a slight clearance. Nozzles **30** establish a communication between the central bore of member **18** and the space between the blades of the bit **2**. An annular recess **31** of the shoulder **19**, provided with an anti-splash screen **32**, opens into the space between the connector and the bit. The recess **31** communicates with the bore **1***b* of connector **1** through orifices **33**. In the bore **1***b* of connector **1** a mass **9**, fastened to the connector, provides for the dynamic balance thereof.

This mass **9** is connected to the movable mass **6** through a spring **11**. As shown in FIGS. **5** and **7**, the movable mass **6** has a finger **34** on which is secured a member **35** which, when the mass moves away from the connector axis, may penetrate an orifice **36** provided in the body of member **18**. The end of said member **35** has a shape complementary to that of a groove **37** of piston **20**.

By this device three operating conditions are possible

a. drilling with rotation of the bit,

b. local measurement of the characteristics of the ground layer at a selected depth with the bit stopped,

c. continuous measurement of the characteristics of a ground layer during the advance of the bit without rotation thereof.

During the drilling stage with rotation of the bit **2**, the penetrometer has the position shown in FIG. **4**, i.e, the tip of the penetrometer is inside member **18**. The bit being slightly above the forehead, the drill string is driven in rotation.

This rotation imparts to the movable mass **6** a centrifugal force F(FIG. **5**) which makes the same prove away from the connector axis and pivot on shaft **7** of bearing **24**. By its displacement the mass **6** produces the stretching of spring **11** (FIG. **5**) and drives the finger **34** and the shaft **7** to which it is connected. In this movement the finger **34** introduces member **35** into the orifice **36** (position shown in FIGS. **5** and **7**) while the shaft **7** brings the obturation member **8** closer to the bit axis until it reaches the position shown in FIGS. **4**, **5** and **6**. The surface **8***a* of member **8** is covered with an abrasive layer, for example a diamond concretion. At this moment the drilling fluid is introduced under pressure in the drill string at a pressure P_1 at least equal to the flushing pressure at the forehead during the drilling stage. The drilling fluid thus exerts on surface **20***b* of piston **20**, whose central bore **20***a* is obturated by the penetrometer, a force which imparts a downward motion to the piston until the groove **37** comes in abutment against member **35** (FIG. **7**).

This abutment reduces the downward stroke of piston **20** so as to leave a clearance about the piston head and the internal wall of member **18** which is sufficient to the passage of the drilling fluid towards orifices **23** through the path indicated by arrows in FIGS. **4** and **7**.

In this position the central duct **20***a* is still blocked by the penetrometer **17** (FIG. **4**) and all the drilling fluid is discharged from the drill string through orifices **23** in the annular space **1***b*, then passes through orifices **33** and recess **31** and, after flowing through the anti-splash screen **32**, irrigate the forehead through orifices **38** of the bit.

By use of the anti-splash screen **32** the flow rate of the drilling fluid can be reduced to such a value that the drilling fluid no longer breaks up the forehead below the bit, said value being still sufficient to ensure the clearing of the forehead and to prevent any collapsing of the lateral wall of the drilled well. During the advance of the string in the drilling stage the member **8** breaks up the core as formed in the central part of bit **2**.

When is reached the desired depth at which a measurement has to be carried out by means of the penetrometer, the bit is disengaged from the forehead. The drilling fluid pressure is decreased to a value lower than P_1. The spring **21** produces the lift of the piston, thereby disengaging the groove **37** of the latter from member **35**. The rotation of the bit is stopped. The centrifugal force applied to the movable mass **6** is nullified. The spring **11** brings nearer to the connector axis the movable mass **6** which actuates, through axis **7**, the obturation member **8** to a position leaving free the central orifice **29** for the passage of the stem **4** of the penetrometer. The latter is then driven into the ground layers under the forehead, after passage through orifice **29** and the central bore of the bit.

In this position for local measurement, the fluid, which is at a pressure P_2 lower than P_1, flows as previously indicated, the central duct **20***a* of piston **20** being still blocked by penetrometer **17**.

When it is desired to measure in a continuous manner the characteristics of a ground layer having a depth greater than the length of the penetrometer stem projecting outside the bit, the following operations are carried out : at the end of the drilling stage the above-indicated operations are repeated so as to stop the rotation of the bit and produce the outgoing of the penetrometer tip. The drilling fluid pressure is then increased, which results in a lowering of the piston to a position at which it blocks orifices **23** and the central duct **20***a* is no longer blocked by the penetrometer. The drilling fluid is then discharged through the central duct **20***a* of piston **20**. The orifice **29** being blocked by the penetrometer stem, the fluid under pressure is violently ejected through nozzles **30** towards the forehead. There is thus achieved a drilling by "jets" which progressively breaks up the forehead and makes possible the advance of the bit therethrough without rotation thereof. Of course this operating conditions are used only in ground layers the hardness of which is not too high so as to make possible the drilling by jets.

From the foregoing description, one skilled in the art can easily ascertain the essential characteristics of this invention and, without departing from the spirit and scope thereof, can make various changes and modifications to adapt it to various usages and conditions.

For example, to the drilling fluid distribution member can be associated a device for generating pressure pulses in a coded form which are transmitted through the drilling fluid to the surface installation where they are detected and used for controlling the operation of the device of the invention. Accordingly such changes and modifications are properly, equitably and intended to be within the full range of equivalence of the following claims.

What we claim is:

1. A device for connecting a drill bit having a central bore to the end of a drill string, at the lower part of which is incorporated an apparatus for measuring the mechanical characteristics of the ground, comprising a stem of a diameter at most equal to that of the central bore of the bit, said stem being provided with elements for measuring the resistant forces opposed by the ground to the penetration of the stem, said device being adapted to be triggered from a position for drilling at which the stem is withdrawn inside the drill string which is then driven in rotation, to a position for measurement at which said rotation is stopped and the stem driven into the ground through said central bore of the bit, said device comprising

at least one articulated member for obturating the drill bit central bore, provided at its lower end with elements for the ground attack, said member being adapted to provide automatically for the closure of the drill bit central bore in response to the centrifugal force generated by the rotation of the bit, and means for return of said member to a position leaving open the bit central bore in the absence of rotation of the bit.

2. A device according to claim 1 wherein during the drilling stage the reaction forces of the ground onto said obturation member have at least one component which maintains said member in position for drilling.

3. A device according to claim 1 comprising a rigid tubular connector coupled at one end thereof with a drill string and at the other end with the bit, the obturation member having an articulation axis on said connector, a movable mass housed inside said connector, solid with said obturation member, and adapted to cause the rocking of said member to a position of obturation is response to the centrifugal force which moves it away from said connector axis during the rotation of the bit, a stationary mass solid with said connector and ensuring the dynamic balance thereof, and an elastic device interconnecting said masses and ensuring the back motion of said obturation member to an opening position of the bit central bore by bringing said movable mass closer to said connector axis in the absence of bit rotation.

4. A device according to claim 1 comprising a rigid tubular connector coupled at one of its ends with a drill string and at its other end with a drill bit, said obturation member having an articulation axis on said connector, a movable mass housed inside said connector, solid with said obturation member and adapted to control the driving of said member to a position of obturation in response to the centrifugal force which moves it away from said connector axis during the rotation of the bit, a stationary mass, solid with said connector and ensuring the dynamic balance thereof, an elastic device interconnecting said masses and ensuring the back motion of said obturation member to a position of free opening of the bit central bore by bringing said movable mass closer to said connector axis in the absence of rotation of the bit, and a drilling fluid distributor secured inside said connector and controlling the irrigation of the bit forehead.

5. A device according to claim 4 wherein said distributor comprises a cylindrical body having a central bore, said body being housed into said connector and defining an annular space inside the same, said annular space communicating with discharge orifices for the drilling fluid clearing out the cuttings from the forehead, a piston slidably mounted in the central bore of said body and comprising a central duct for the passage of said measuring stem, said piston being maintained through elastic means, for a value of the fluid pressure lower than a predetermined threshold value, to a first position of obturation of said central duct at which the fluid from the drill string is only discharged to said internal annular space, through communication orifices provided through the distributor body, said piston being adapted to be displaced, during the rotation of the bit and in response to a fluid pressure at least equal to said threshold value, against the antagonistic action of said elastic means until it reaches a second position of obturation of said central duct at which the fluid is exclusively discharged into said internal annular space through said communication orifices provided through the distributor body, said piston being displaced, in the absence of rotation of the bit and in response to a fluid pressure at least equal to said threshold value, against the antagonistic action of said elastic means until it reaches a position of obturation of said communication orifices and of free opening of said central duct of the piston, at which the drilling fluid flows exclusively through said central duct, communicating, on the one hand with an orifice for the passage, with a small clearance, of the measuring stem, located at the base of the drill bit connector and, on the other hand with the ducts inclined with respect to the connector axis and adapted to ensure the drilling with fluid jets.

6. A device according to claim 5, wherein said second position of obturation of said piston central duct, attained during the drill bit rotation and in response to a fluid pressure at least equal to said threshold, is determined by means for limiting the displacement of said piston in the position of the movable mass remote from said connector axis.

7. A device according to claim 6 wherein said means for limiting said piston displacement comprise complementary elements consisting of a groove and a locking finger, one of said elements being associated with said piston and the other with said movable mass.

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