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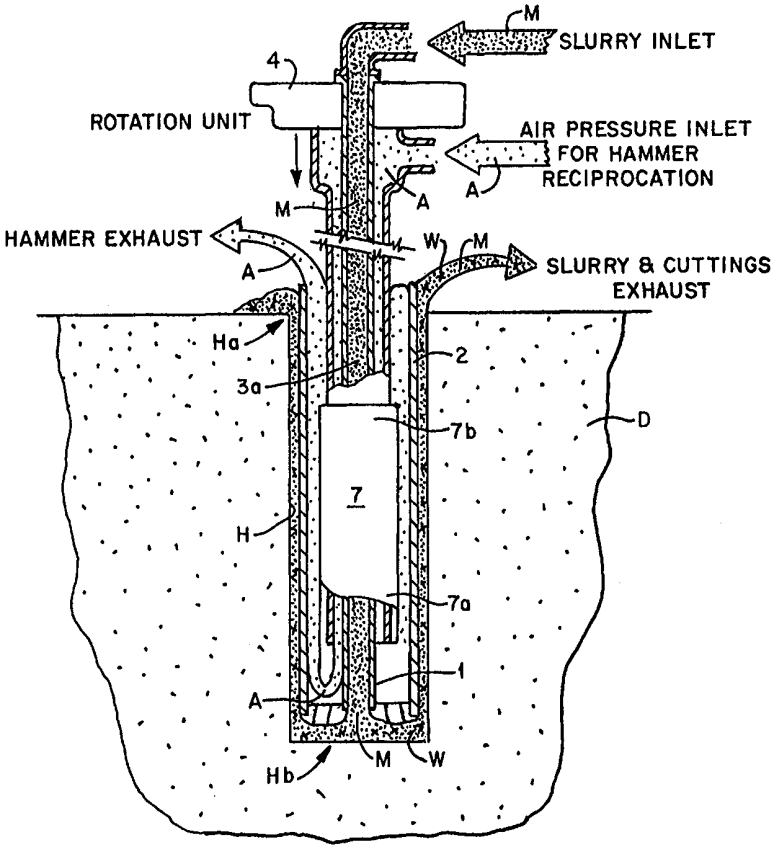
**(54) Title:** METHOD AND DEVICE IN DOWN–THE–HOLE DRILLING

**(57) Abstract**

The invention relates to a method, device and drill bit for lining down–the–hole drilling, wherein a pipe (2) is installed after a drill bit (1) in a drill hole (H) made by the drill bit (1), and drill cuttings (W) produced in the drilling is removed by means of a flushing medium introduced in the drilling location (Hb) through the drill bit (1). In the invention, the flushing medium (M) used is preferably drilling mud or a corresponding flowing medium which is led with the drill cuttings (W) from the drilling location (Hb) substantially along the pipe (2) back towards the starting point (Ha) of the drill hole (H).



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# METHOD AND DEVICE IN DOWN-THE-HOLE DRILLING

The invention relates to a method in lining down-the-hole drilling according to the preamble of claim 1. The invention also relates to a lining down-the-hole drilling device according to the preamble of claim 14. The invention relates further to a drill bit for a lining down-the-hole drilling device according to the preamble of claim 19.

In so-called lining drilling, a drill bit is used which is brought into a percussion movement by means of a percussion hammer and which makes a hole in the ground. The drill bit and the percussion hammer are followed by a drill rod which is fed into the hole. An outer pipe surrounding the percussion hammer and the drill rod remains in the finished hole, and the drill bit is drawn by means of the drill rods within the pipe after the drilling has been completed. In down-the-hole drilling, the percussion hammer is placed in the hole to be made. To make the percussion movement of the percussion hammer, a pressurized medium is used, typically air, which is led to the percussion hammer inside the drill rod which is placed inside the pipe.

A problem in the described down-the-hole drilling method is the removal of the drill cuttings. As a flushing medium, it is typical to use air which is led through the drill bit to the drilling point and back to the starting point of the drilling inside a pipe, as presented e.g. in a lining down-the-hole drilling device according to U.S. patent 5,590,726. In a known manner, the flushing medium in down-the-hole drilling devices consists of air which is supplied from a percussion hammer, fed as a pressurized medium to the percussion hammer and, after the use, led from the percussion hammer through the drill bit to the drilling point and further substantially unpressurized backwards along the pipe, in this case primarily inside the pipe.

However, a particular problem in the above-described methods is that it is problematic to feed air into the ground if the ground is composed at least partly of a relatively soft soil material, such as clay and/or gravel/ moraine. For example in many regions in Finland, former or present building areas comprise a surface clay layer with a thickness of approximately 10 to 40 meters, underneath that a more coarse material,

such as gravel and/or moraine, and underneath that finally competent rock. To flush the drill cuttings, air conveyed to the drilling point tends to create pockets and cavities in the soft soil material which considerably impair e.g. the cohesion of pipes left as piles in pile work in the surrounding ground or also the supporting power of old piles in re-piling. For this reason, the use of air is being prohibited in earth drilling in many cities.

It is an aim of the invention to present a method and a device to avoid the above-mentioned disadvantages. For achieving this aim, the method according to the invention is primarily characterized in what will be presented in the characterizing part of claim 1. The device according to the invention is primarily characterized in what will be presented in the characterizing part of claim 14. The drill bit according to the invention is primarily characterized in what will be presented in the characterizing part of claim 19.

An important principle in the invention is that the flushing medium intended for flushing the drill cuttings from the drilling point is brought along a drill rod inside a pipe that will remain in the ground, separately from the pressurized medium producing the percussion movement of the drill bit, and it is led through the drill bit, after which it flushes the drill cuttings off the drilling point and returns to the starting point of the drilling in the hole primarily outside the pipe that will remain in the ground. The flushing medium used is drilling mud or a corresponding flowing substance which is more viscous than water. As the drilling mud, it is possible to use e.g. a mixture of bentonite clay and water in a suitable proportion. Thanks to its properties and environmental safety, the invention can be particularly well applied in drilling. In some cases, also water is used as a flushing medium.

Furthermore, it is another important principle in the invention that air is used as the pressurized medium of the percussion hammer, but after the use it is led from the percussion hammer preferably to the drill bit and further primarily inside the pipe, wherein it does not enter into the drilling location or the ground. Air is suitable as a pressurized medium particularly

due to its environmental safety, and moreover, no separate system will be needed to recover and purify used air, wherein the air can be discharged in the environment at the location of starting of the drilling. Instead of air, it is in some cases possible to use also pressurized water or hydraulic fluid, if the apparatus and the drilling are suitable for the use of these pressurized media.

According to an advantageous embodiment of the invention, the drill bit is preferably provided with a channelling for conveying at least part of the flushing medium and simultaneously the drill cuttings inside the pipe and further towards the starting point of the drilling. Thus, it is possible to improve the discharge of the flushing medium and the drill cuttings from the drilling point and from the drill hole.

When the drill hole is viewed in a cross-section particularly at the location of the drill rod, the drill rod is provided with a central tubular channelling for the supply of the flushing medium, around the same in the drill rod an annular channelling for the supply of the pressurized medium, further around the same with an annular channelling for the return of the pressurized medium (and in one case also the flushing medium), and further around the same with an annular channelling between the pipe and the drill hole for the return of the flushing medium and the drill cuttings (and in one case also the pressurized medium).

Furthermore, it is essential in the method that in a relatively soft soil material, such as clay, gravel or the like, it is possible to produce an earth-drilling working only by rotation of the drill bit; in other words, no pressurized medium is led to the percussion hammer in connection with the drill bit. This has the advantage that disturbing noise can be avoided particularly in dwelling areas. When a harder soil material is struck, such as bed-rock or a larger block of stone, the operation is changed to percussion, and the rotation is continued.

The method suits particularly for piling of buildings and re-piling of old buildings.

In the following, the invention will be described in more detail with reference to the appended drawings, in which

Fig. 1 illustrates the method of the invention in a leading principle,

Fig. 2 shows the drilling point in a longitudinal cross-section of a down-the-hole drilling device according to a preferred embodiment to be applied in the invention, and

Fig. 3 shows a preferred embodiment of a down-the-hole drilling device that is suitable for use in the invention, in a longitudinal cross-section.

Figure 1 shows earth drilling, in this case piling of buildings. A pipe 2 to remain in the ground is fed into a drill hole H made from above with a drill bit 1 from a starting point Ha of the drilling, which can be in the case of re-piling a place inside a building, such as a basement, or in new building sites a place in the open air. The pipe 2 is fed vertically into the ground by feeding shorter pipe sections in succession. Inside the pipe 2 there is a drill rods which also consists of successive lengths. The feeding and assembly of the portions of the drill rod 3 and the portions of the pipes 2 can be accomplished by solutions of prior art.

An actuator which is located on the ground surface, usually in the vicinity of the starting point Ha of the drilling, and which produces the rotary movement in the drill bit 1 and supplies, if necessary, pressurized medium A to a percussion hammer 7 to achieve a percussive movement of the bit 1, is illustrated in a reduced manner with reference numeral 4. In this description, the drill bit 1 also refers to a bit assembly which may also comprise several separate parts, such as a shank part and an actual percussive part.

A flowing, viscose medium M, or flushing medium M, to flush out drill cuttings W produced at a drilling location Hb in front of the drill bit 1, is supplied along the drill rod 3, more precisely along a first channelling 3a located centrally inside the drill rod 3, and the flushing medium M rises upward from the drilling location Hb with the drill cuttings W. The flushing medium M rises in a narrow space between the drill hole H and the outer surface 2a of the pipe 2, touching the pipe 2 and simultaneously lubricating the outer surface 2a of the pipe 2. Because the flushing

medium M is a relatively viscose flowing substance, it will not penetrate further in the soil material or form cavities.

On the ground surface, there is a feeder pump for pressurizing the flushing medium M to a sufficient extent. The flushing medium M that has risen back along the drill hole H is purified from the drill cuttings W with a filter and recirculated into the drill rod 3.

Figure 2 shows the drilling location Hb in a longitudinal cross-section. With reference to Figs. 1 and 2, the drilling location Hb accommodates a drill bit 1 which makes a recessing hole or drill hole H in a soil material D by means of rotation and flushing with a flushing medium M or, depending on the soil material D, by means of rotation, an alternating percussive movement and flushing. The bit 1 is fixed, in a known manner, to second end 7a of a percussion hammer 7 which is at its first end 7b attached to the front end 3b of a drill rod 3. A first channelling 3a is brought through the drill rod 3 and the percussion hammer 7, extending in one or several channels through the drill bit 1 and opening into the drilling location Hb. The flushing medium M, whose path is indicated with arrows in Fig. 2, is transferred with drill cuttings W from the drilling location Hb back towards the starting point Ha of the drill hole H outside the pipe 2 that remains in the ground D. Figure 2 also shows how, in accordance with a preferred embodiment of the invention, the down-the-hole drilling device further comprises a ring auger bit 5 outside the drill bit 1, the ring auger bit 5 being fixed at the end of the pipe 2 and remaining in the ground when the drill rod 3, the percussion hammer 7 and the drill bit 1 are pulled up again after the drilling has been completed.

Further, with reference to Figs. 1 and 2, it is also shown how the pressurized medium A brought to the percussion hammer 7 can be led back to the starting point Ha of the drill hole H. A second channelling 6 is introduced from the exhaust channel system 6 of the percussion hammer 7 to the drill bit 1, the channelling 6 extending first in the axial direction (arrow X) around the first channelling 3a for the flushing medium M and extending then diagonally backwards and opening into a space between the hammer 7 and the inner surface 2b of the pipe 2, where it extends

along the pipe 2 backwards towards the starting point Ha of the drill hole H. The pressurized medium A is thus conveyed substantially along the whole length of the drilling device first in the space between the hammer 7 and the pipe 2 and then in the space between the drill rod 3 and the pipe 2 upwards towards the starting point Ha of the drill hole H. The pressurized medium A is preferably air which is pressurized e.g. with a compression pump close to the starting point Ha of the drill hole H. It is obvious that due to leaks, pressurized medium A also escapes outside the pipe 2 and flushing medium H inside the pipe 2. It should also be mentioned that the second channelling 6 can also be arranged at least partly in such a way that the wall of the channelling 6 is formed partly in the drill bit 1 and the rest of the wall is formed in the other structures of the device, wherein the channel formed in the drill bit 1 can be through-like.

Figure 3 shows a preferred embodiment of a down-the-hole drilling device that is suitable for use in the invention. The figure shows the front end 3b of a drill rod 3 to which the percussion hammer 7 of the device is coupled at its first end 7b, its second end 7a being equipped with a drill bit 1. A piston performing a reciprocating motion by the effect of the pressurized medium A inside the percussion hammer 7 is indicated with reference numerals, and the channels of the flushing medium M and the pressurized medium A are indicated with the same reference numerals 3a and 6 as above. The device of Figure 3 is located inside the pipe 2 in the drill hole, but in this figure, the device is shown without this external pipe 2 and the ring auger bit 5 which are visible in Figure 2.

According to a preferred embodiment of the invention, at least some of the pressurized medium A is led to the drilling location Hb from which is it led with the flushing medium M back towards the starting point Ha of the drill hole H. This can be accomplished by means of a third channelling 9 formed in the drill bit 1 to convey the pressurized medium A at least partly from the second channelling 6 to the drilling location Hb. The principle is illustrated in Figure 2 with an arrow 9 which shows the channelling to be formed.

According to a preferred embodiment of the invention, at least some of the flushing medium M, along with drill cuttings W. is conveyed from the drilling location Hb to the inside of the pipe 2, from which it is led with the pressurized medium A back towards the starting point Ha of the drill hole H. This can be accomplished by means of a four channelling 10 formed in the drill bit 1 to convey the flushing medium M at least partly from the drilling location Hb to the inside of the pipe 2. The principle is illustrated in Figure 2 with an arrow 10 which shows the channelling to be formed.

Preferably the first, second, third and fourth channelling 3a, 6, 9 and 10 to accomplish the operation according to the invention are formed at least partly in the drill bit 1. By varying the sizes of the channellings it is possible to affect the quantity of the medium to be conveyed. As the channellings are formed in the drill bit 1, it is possible to change the principle of operation of the device simply by changing the drill bit 1 in the device, wherein the rest of the device, including the percussion hammer, can be kept substantially unchanged.

The present invention is not limited solely to some preferred embodiments used above as examples, but it can be modified within the scope of the appended claims. The more detailed embodiment of the structures is variable, and the invention can be applied not only in drilling methods implemented with a ring auger bit but also in other drilling methods in which a space is provided for a pipe, for installing the same in a drill hole. The drill bit can be separate from the pipe or it can be fixed to the pipe by using known methods in conjunction with the method of the invention. As to installing the pipe in connection with the drill hole, the methods include inserting the pipe in the drill hole, pulling it into the hole by means of a bit assembly, or pulling it with wire ropes.

Claims:

1. A method in lining down-the-hole drilling, wherein a pipe (2) is installed with a drill bit (1) in a drill hole (H) made by the drill bit (1), and drill cuttings (W) produced in the drilling are removed by means of a flushing medium introduced in the drilling location (Hb) through the drill bit (1), **characterized** in that the flushing medium (M) used is preferably drilling mud or a corresponding flowing medium which is led with the drill cuttings (W) from the drilling location (Hb) substantially along the pipe (2) back towards the starting point (Ha) of the drill hole (H).

2. The method according to claim 1, **characterized** in that the flushing medium (M) is led with the drill cuttings (M) from the drilling location (Hb) back towards the starting point (Ha) of the drill hole (H) substantially outside the pipe (2).

3. The method according to claim 1 or 2, **characterized** in that pressurized medium (A) used for producing the percussion movement of the drill bit (1) is returned substantially inside the pipe (2), between the pipe (2) and the drill rod (3).

4. The method according to any of the claims 1 to 3, **characterized** in that the flushing medium (M) is supplied to the drill bit (1) in the hole (H) inside the drill rod (3) extending in the pipe (2), separately from the pressurized medium (A) used for producing the percussion movement of the drill bit (1).

5. The method according to any of the claims 1 to 4, **characterized** in that the pressurized medium (A) used for producing the percussion movement of the drill bit (1) is preferably air which is supplied inside the drill rod (3) extending inside the pipe (2).

6. The method according to any of the claims 1 to 5, **characterized** in that at least some of the pressurized medium (A) is supplied to the drilling

location (Hb) to be returned with the flushing medium (M) from the drilling location (Hb) towards the starting point (Ha) of the drill hole (H).

7. The method according to any of the claims 1 to 6, **characterized** in that at least some of the flushing medium (M) is led from the drilling location (Hb) to the inside of the pipe (2) to be returned with the pressurized medium (A) towards the starting point (Ha) of the drill hole (H).

8. The method according to claim 6 or 7, **characterized** in that pressurized medium (A) is led to the inside of the pipe (2), preferably pressurized medium (A) is also led to the drilling location (Hb) and preferably also flushing medium (M) is led from the drilling location (Hb) through the drill bit (1 ) to the inside of the pipe (2).

9. The method according to any of the claims 1 to 8, **characterized** in that the drill bit (1) is rotated without a percussive action in a relatively soft soil material (D), such as loose soil material.

10. The method according to any of the claims 1 to 9, **characterized** in that instead of rotating the drill bit (1), the drill bit (1) is percussed when it hits a harder soil material (D), such as rock or stone.

11. The method according to any of the claims 1 to 10, **characterized** in that it is used for piling of buildings, wherein substantially vertical drill holes (H) are drilled in the ground, where the pipes (2) remain as piles.

12. The method according to any of the claims 1 to 11, **characterized** in that it is used in re-piling of buildings, wherein substantially vertical drill holes (H) are drilled alongside old piles, the pipes (2) remaining as piles in the drill holes (H).

13. The method according to any of the claims 1 to 12, **characterized** in that the flushing medium (M) is water or a mixture of bentonite clay and water.

14. A lining down-the-hole drilling device, the device comprising:

a percussion hammer (7) to be fitted inside a pipe (2) during the drilling, the first end (7b) of the percussion hammer (7)being arranged to be fixed to a drill bit (3) extending inside the pipe (2), and

a drill bit (1) arranged at the second end (7b) of the percussion hammer (7), a first channelling (3b) extending through the drill bit (1) for substantially leading flushing medium (M) into the drilling location (Hb) and further along the pipe (2) from the drilling location (Hb), **characterized** in that

the percussion hammer (7) is provided with a second channelling (6) for substantially conveying pressurized medium (A) used for producing a percussion movement to the inside of the pipe (2), the second channelling (6) being arranged to be connected to a corresponding channelling (6) of the pressurized medium (A) formed inside the drill rod (3),

that the first channelling (3a) is arranged to extend centrally through the percussion hammer (7) and is arranged to be connected to a corresponding channelling (3a) of the flushing medium (M) formed inside the drill rod (3).

15. The down-the-hole drilling device according to claim 14, **characterized** in that the flushing medium (M) is arranged to be returned with the drill cuttings (W) from the drilling location (Hb) towards the starting point (Ha) of the drill hole (H) substantially outside the pipe (2).

16. The down-the-hole drilling device according to claim 13 or 14, **characterized** in that it is arranged to be connected to a drill rod (3) which is provided in the axial direction (X) with a tubular first channelling (3a) and an annular second channelling (6) around said first channelling (3a).

17. The down-the-hole drilling device according to any of the claims 13 to 16, **characterized** in that the drill bit (1) is provided with a third channelling (9) for conveying pressurized medium (A) at least partly from the second channelling (6) to the drilling location (Hb).

18. The down-the-hole drilling device according to any of the claims 13 to 17, **characterized** in that the drill bit (1) is provided with a fourth channelling (10) for conveying flushing medium (M) at least partly from the drilling location (Hb) to the inside of the pipe (2).

19. A drill bit for a lining down-the-hole drilling device, the drill bit (1) comprising at least a first channelling (3a) extending through the drill bit (1) for conveying a flushing medium (M), preferably drilling mud, to a drilling location (Hb), **characterized** in that the drill bit (1) also comprises a second channelling (6), separate from the first channelling (3a), substantially for conveying a pressurized medium (A), preferably air, to the drill bit (1) and further between the down-the-hole drilling device and a pipe (2) to be fitted around the device.

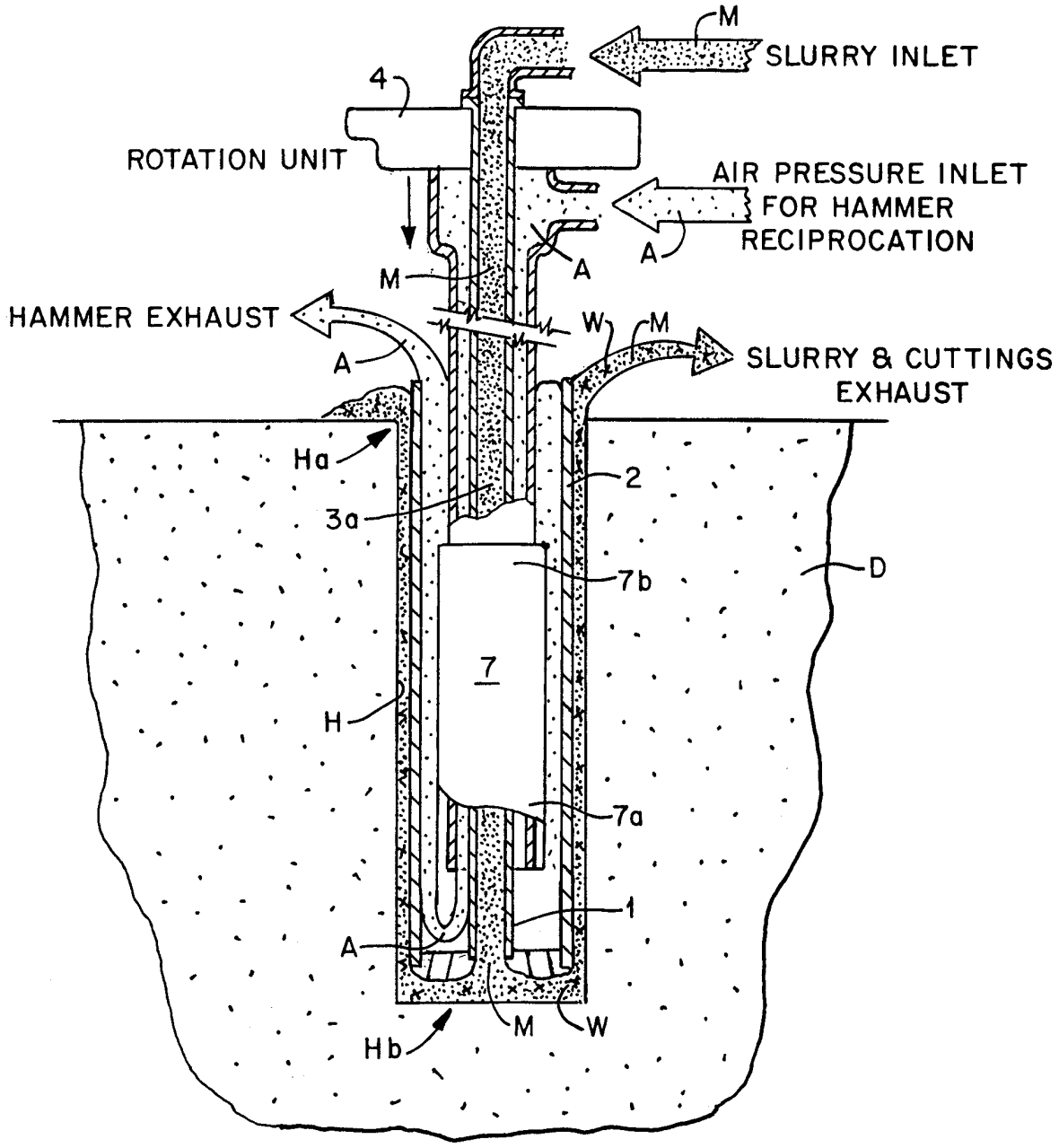
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FIG. 1

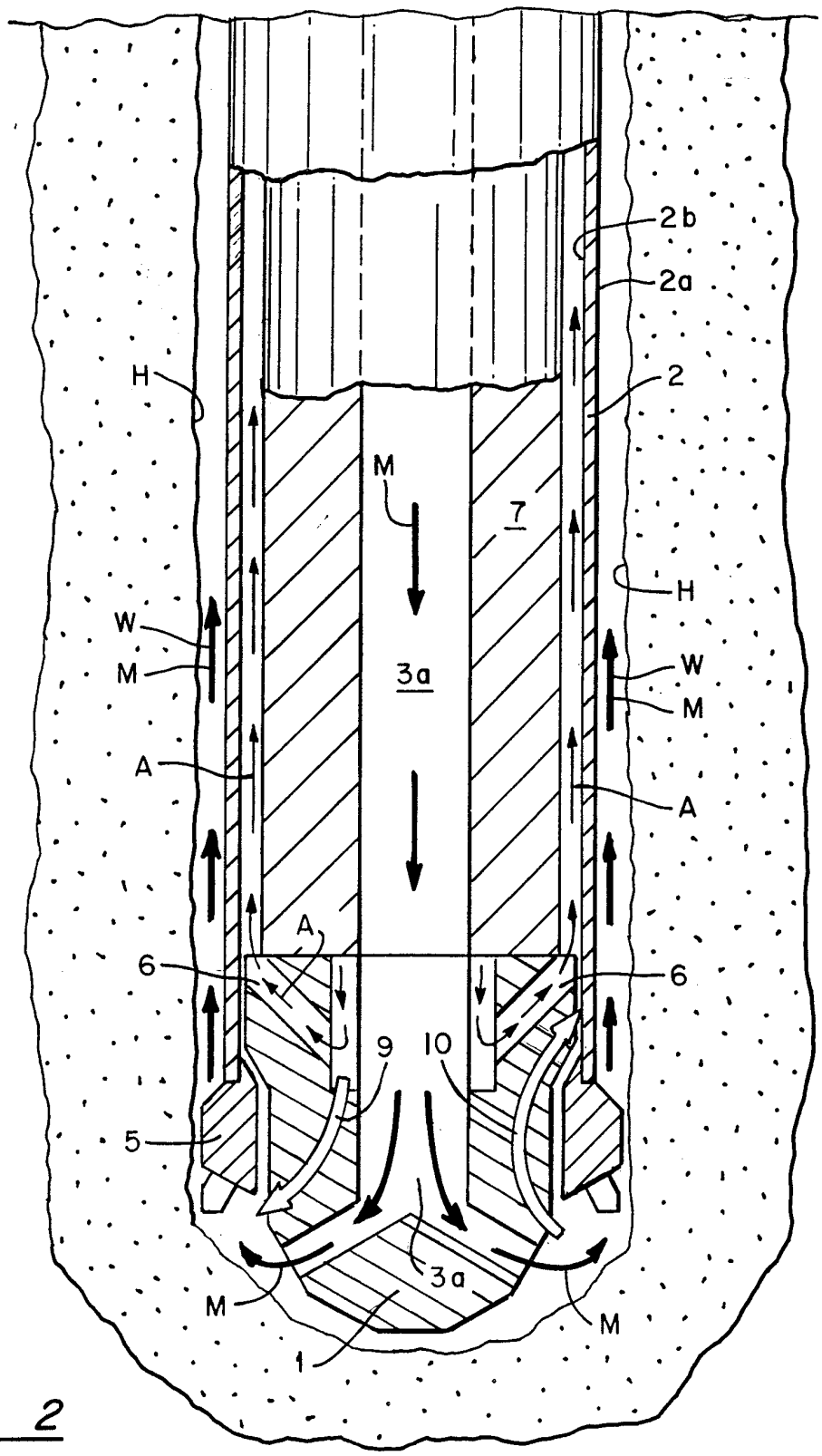


FIG. 2

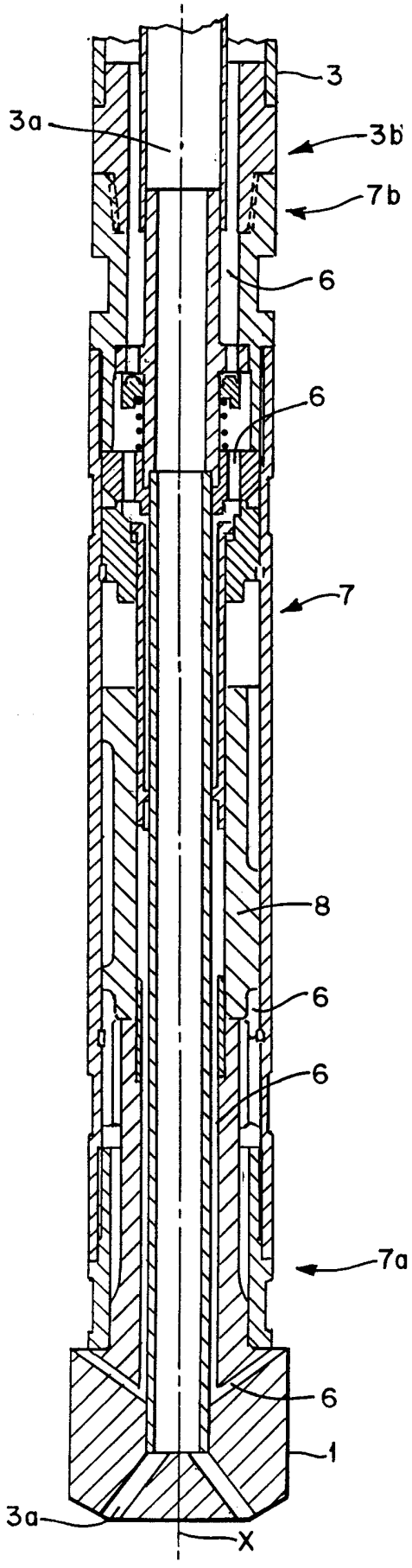


FIG. 3

# INTERNATIONAL SEARCH REPORT

International application No.
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A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :F21B 10/36
US CL :175/57

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)

U.S. : 175/57, 339, 340, 393, 417, 418, 296, 297, 293, 215, 92; 173/73, 116, 119, 120, 134

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EAST, WEST

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| Y | US 5,803,187 A (JAVINS) 08 September 1998 (08/09/98), see entire document. | 1-19 |
| Y | US 4,819,746 A (BROWN ET AL) 11 April 1989 (11/04/89), see entire document. | 1-19 |
| Y | US 4,828,048 A (MAYER ET AL) 09 May 1989 (09/05/89), see entire document. | 1-19 |
| Y | US 5,396,965 A (HALL ET AL) 14 March 1995 (14/03/95), see entire document. | 1-19 |

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