July 15, 1969 W. TIRASPOLSKY 3,455,402

DRILLING DEVICE

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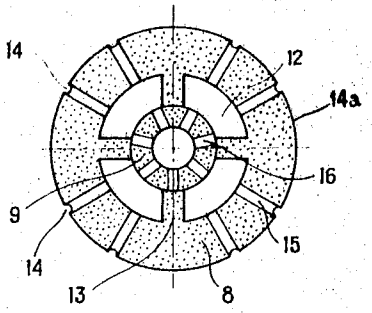

Fig. 1A

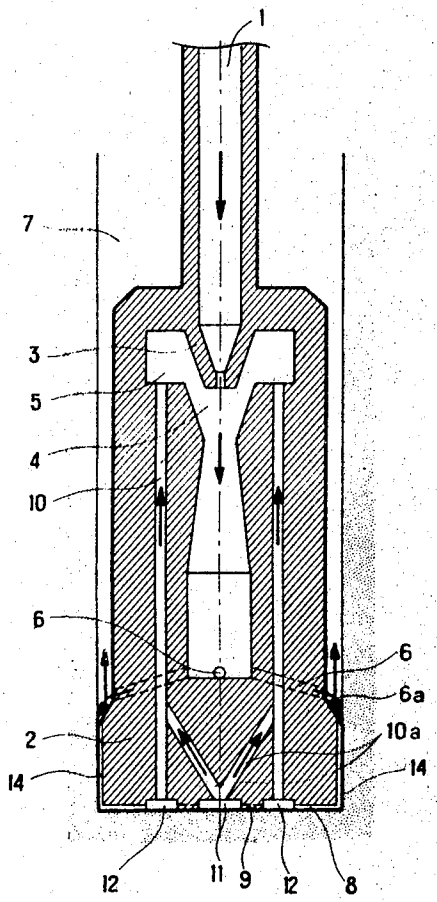

Fig. 1

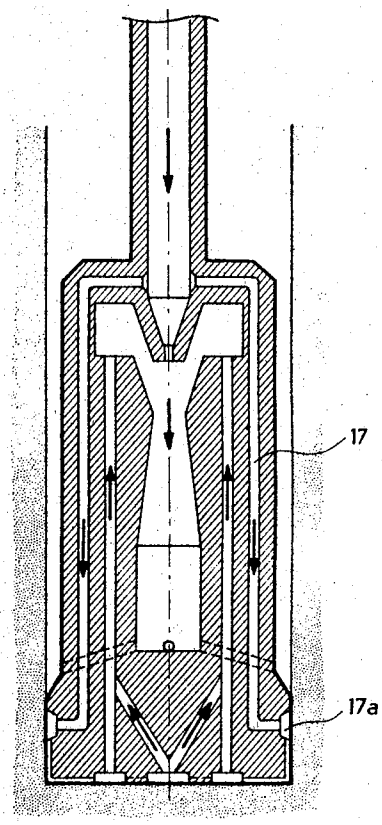

Fig. 2

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DRILLING DEVICE

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ABSTRACT OF THE DISCLOSURE

The present invention relates to a new drilling device allowing to increase the efficiency of the drilling methods using a circulation of flushing fluid, by increasing in particular the drilling rate of the drill bit and extending the working life thereof.

The main object of the invention is to provide an increased drilling efficiency by substantially preserving the working areas of the drill bit from the pressure of the flushing fluid at the lower part of the annular space included between the wall of the drilled well and the drill string and by providing in these working areas a pressure which does not substantially exceed the hydrostatic pressure prevailing in the drilled ground layer in the vicinity of the working area, and which may be smaller than this hydrostatic pressure.

The drilling device according to the invention which permits to achieve this result includes a bit body, at least a working area provided on said bit body and limiting a working surface, means for providing in a zone of said bit body a negative pressure with respect to the pressure of the flushing fluid feeding the bit.

This device is characterized by the combination of at least one lifting channel for the ground cuttings, connecting said working area with said zone of negative pressure and opening out into the annular space between the drill string and the wall of the drilled well through at least one orifice located outside said working area, and means for limiting the flow rate of flushing fluid between said orifice of the lifting channel and said working area.

The drill bit used in the device according to the invention will be either of a type with which the disaggregation of the ground is obtained solely by the rotation of the tool, or of a type destructing the ground by percussion effects which may or not be combined with the rotation effect.

Some non limitative embodiments of the drilling device according to the invention will now be described with reference to the attached drawings wherein:

FIGURE 1 is a diagrammatic front view of the whole drilling device in a first embodiment of the invention,

FIGURE 1A is a bottom view of the drill bit in the same embodiment,

FIGURE 2 illustrates, also diagrammatically, a second embodiment of the invention.

In the embodiments of the invention which have been illustrated by way of example, the drilling device is provided with a solid drill bit.

This device is connected with the drill string **1** and includes a nozzle **3**, supplied with flushing fluid flowing in the direction of the arrow from the drill string **1** cooperating with a venturi **4** located in the extension of the nozzle so as to create a negative pressure in the annular chamber **5**.

In the following reference will first be had to the first embodiment illustrated by FIGURES 1 and 1A.

Many outlet channels **6** for discharging the flushing fluid and the ground cuttings conveyed by this fluid toward the annular space **7** surrounding the drill string are supplied with flushing fluid through the venturi and have orifices **6***a* located behind the working areas **8** and **9**, with respect to the direction of advance of the drill bit.

Channels **10**, **10***a* for lifting the cuttings from the working areas are connected with the annular chamber **5**, in which a negative pressure is created and open out in the vicinity of the working areas through a central draining recess **11** and intermediate draining recesses **12**.

The working areas in contact with the well bottom form in this embodiment two annular areas or crowns **8** and **9**, interconnected by radial elements **13**.

A part of the total flow of flushing fluid, flowing from the recesses **6***a* of the outlet channel **6** into the annular space **7** can flow downwardly, as shown by the arrows, to the working areas and thereby provides for the irrigation of the latter by following the longitudinal grooves or channels **14**, provided at the periphery of the head **2** of the drill bit, and the radial grooves or channels **15**, **16** running through the working areas **8** and **9**.

In this embodiment of the invention the flow rate of flushing fluid flowing between the apertures **6***a* of the outlet channels **6** and the lifting channels **10** and **10***a*, is limited by the small section of the free annular space between the lateral wall **14***a* of the head **2** of the drill bit and the lateral wall of the drilled well and specially by an important contact surface of the working areas **8**, **9** and **13** with the hole bottom on the path followed by the fluid flowing across the working surface to the draining recesses **11** and **12**.

The number and cross section of the longitudinal channels **14** and of the radial channels **15** and **16** provided in these working areas, are selected as a function of the flow rate of fluid which must flow from the apertures **6***a* to the outlet recesses **11** and **12** for the irrigation of the hole bottom, and of the desired pressure drop in the working areas with respect to the hydraulic pressure created by the flushing fluid in the annular zone **7** of the well, at the level of the apertures **6***a*.

It will optionally be possible to provide a direct admission of flushing fluid to the working surface through irrigation orifices located in the working areas or slightly behind these working areas, these orifices being fed through channels **6**.

It will then be necessary that these irrigation orifices and the draining recesses **11** and **12** are separated by working areas having a sufficient contact surface with the ground, so as to provide between said orifices and said recesses a pressure drop in the flushing fluid, corresponding to the desired negative pressure in the working areas with respect to the hydraulic pressure in the outlet channels **6**.

Such irrigation orifices located in the vicinity of the working surface may be fed with flushing fluid through irrigation channels provided with means for limiting the flow rate of flushing fluid, such as throttling devices or calibrated apertures, the orifices of these channels fed with flushing fluid being provided with protecting grids preventing the return to the working surface of the cuttings conveyed by the flushing fluid through the lifting channels **10** and **10***a* to the zone of negative pressure and therefrom, through the venturi, to the feed orifices of the irrigation channels.

In the above-described embodiment of the invention the head **2** of the drill bit has a solid substantially cylindrical shape.

It will however be possible, without departing from the scope of this invention, to use drill bits having a different configuration, such as roller bits or bits with a

solid head constituted of a plurality of separated radial elements, by providing within or close to the working areas, orifices of lifting channels for the return of ground cuttings, such as the channels **10**, **10***a* of FIGURE 1, separated from the inlet orifices of the flushing fluid by contact or partition areas provided on the drill bit head, in contact with the hole bottom or with the wall of the drilled well so as to limit the flow rate of fluid flowing to these lifting or return channels.

These contact areas may be constituted by the working areas surrounding the suction or draining orifices of the lifting channels or by separate partitions provided on the drill bit head between the inlet orifices or orifices of the flushing fluid and the suction or drawing orifice or orifices.

The embodiment illustrated by FIGURE 1, while presenting with respect to conventional drilling devices the advantages indicated in the introductory part of this description, may however sometimes, when used for drilling some sorts of grounds, give the problem of drawing off the ground particles, cuttings, . . . etc. . . . which may be accumulated in the annular space above the drill bit and the size of which is too big to allow these cuttings to be drained or drained back toward the suction or draining zone or zones on the hole bottom.

This problem can be solved by carrying out the irrigation of the hole bottom by means of fresh fluid (i.e. fluid which is not loaded wtih cuttings) using by-pass means providing for flowing of a fraction of the flow rate of flushing fluid admitted by the drill string directly to the hole bottom.

FIGURE 2 is a diagrammatic and non-limitative embodiment of a drilling device according to the invention, which is provided with such by-pass means.

In this embodiment the irrigation of the working surface is not provided for by suction through the channels **14** of the flushing fluid flowing from the annular space **7** above the drill bit and loaded with cuttings, but is carried out by sucking flushing fluid from a level above the zone of depression **5**, i.e. flushing fluid which is free of ground cuttings.

This fluid is for example sucked from the nozzles through channels **17** which open out through orifices **17***a* in recesses of the lateral wall **14***a* of the drill bit head, at a slight distance from this wall.

In this embodiment the vertical channels **14** may be interrupted at their upper part, substantially at the level of the orifices **17***a*.

The irrigation channels **17** may also open out substantially at the level of the hole bottom (the channels **14** can then be suppressed) and means for limiting the flow rate of flushing fluid through these channels may then be adapted to these channels themselves.

It must be however understood that the embodiment shown by FIGURE 2 of the means for directly by-passing fresh fluid to the hole bottom is by no way limitative, since the design of these by-pass means must be adapted to the own characteristics of each drill bit which may be used in a drilling device according to the invention.

I claim:

1. In a well drilling device with fluid circulation, adapted to be connected with the lower part of a drill string, including a bit body, at least one working area integral with said bit body and limiting a working face with the ground, means for creating in a zone of said bit body a negative pressure with respect to the feed pressure of said bit with flushing fluid, the combination of at least

one lifting channel for the ground cuttings, said channel connecting said working area with said zone of negative pressure, at least one outlet channel for the flushing fluid, crossing said zone of negative pressure and opening out in the annular space between the drill string and the wall of the drilled well, through at least one orifice located outside said working area, and means for limiting the flow rate of flushing fluid from said orifice to said outlet channel and said working area.

2. Device according to claim **1**, wherein said working area is provided with transverse channels forming a passageway for the cuttings.

3. Device according to claim **1**, wherein said means for creating said negative pressure includes a nozzle fed with said flushing fluid and opening out into a venturi located in the extension of said nozzle, said lifting channel for the cuttings communicating with said venturi.

4. Device according to claim **1**, wherein said means for limiting the flow rate includes at least a contact area of said bit body with said working face, sad contact area being adapted to substantially separate said orifice of said outlet channel from at least one zone of suction of the cuttings, which is connected with said lifting channels.

5. Device according to claim **4**, wherein said contact area includes at least a circular contact area coaxial with said device.

6. Device according to claim **1**, wherein said orifice of said outlet channel is located behind said working area with respect to the direction of drilling of said bit and wherein said means for limiting the flow rate of flushing fluid includes a lateral contact wall of said bit body with the wall of the drilled well, ahead of said orifice of said outlet channel of the flushing fluid.

7. Device according to claim **6**, wherein said contact area includes at least a contact area having a substantially radial direction with respect to the axis of said device.

8. Device according to claim **6**, wherein said lateral wall of said bit body in contact with the wall of the drilled well is provided with channels for the flowing of the flushing fluid from said orifice of the outlet channel to said working area and said lifting channel.

9. A device according to claim **1**, wherein are provided means for directly by-passing to said working face the flushing fluid flowing from said drill string.

10. A device according to claim **9**, including at least a channel for irrigating said working area with flushing fluid derived from a level above said zone of negative pressure, said channel opening out outside said working area, said device further including means for limiting the flow rate of flushing fluid between said irrigation chnnel and said working area.

11. Device according to claim **10**, wherein said irrigation channel has at least one orifice on a lateral wall of said bit body.

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