United States Patent

Okuyama et al.

[15] **3,661,219**

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[54] DRILLING SYSTEM

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[52] **U.S. Cl.**.....**175/260**

[51] **Int. Cl.**.....**F21b 9/26**

[58] **Field of Search**.....175/260, 261

[56] **References Cited**

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[57] **ABSTRACT**

This invention relates to a drilling system wherein a latching device is integrally provided with a bit and a reaming device and is engaged with a drill stem so that the rotating force and propelling force of the drill stem may be transmitted directly to the bit and blades of the remaining device from the lower end of the drill stem.

6 Claims, 6 Drawing Figures

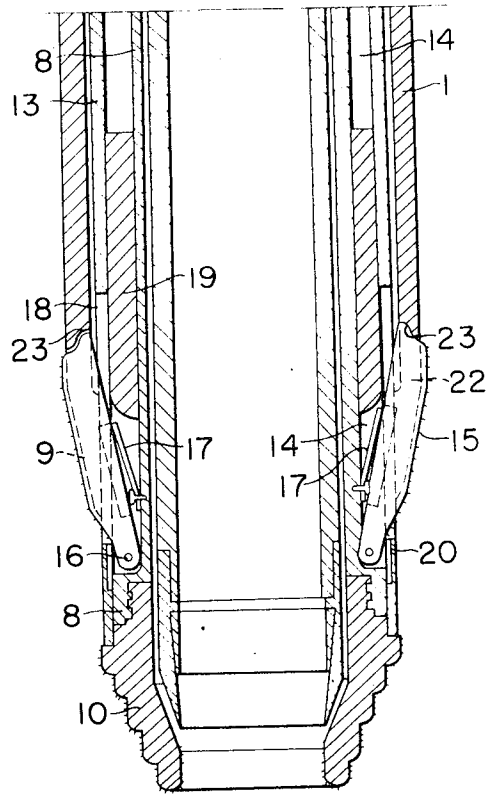

FIG. 1

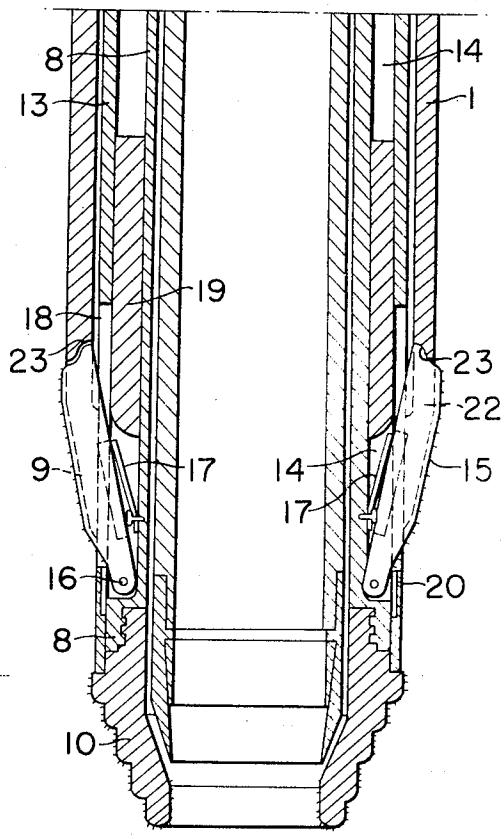

FIG. 2

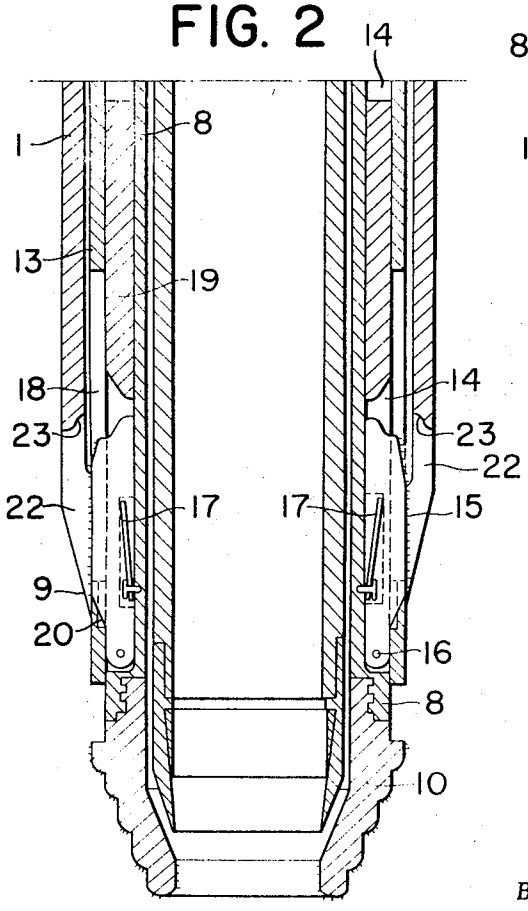

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FIG. 3

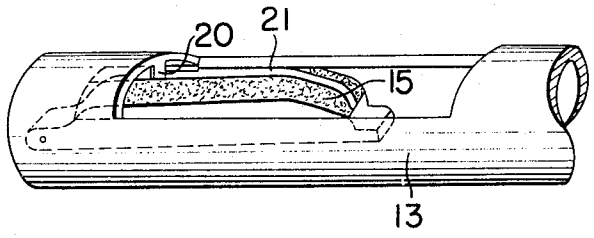

FIG. 4

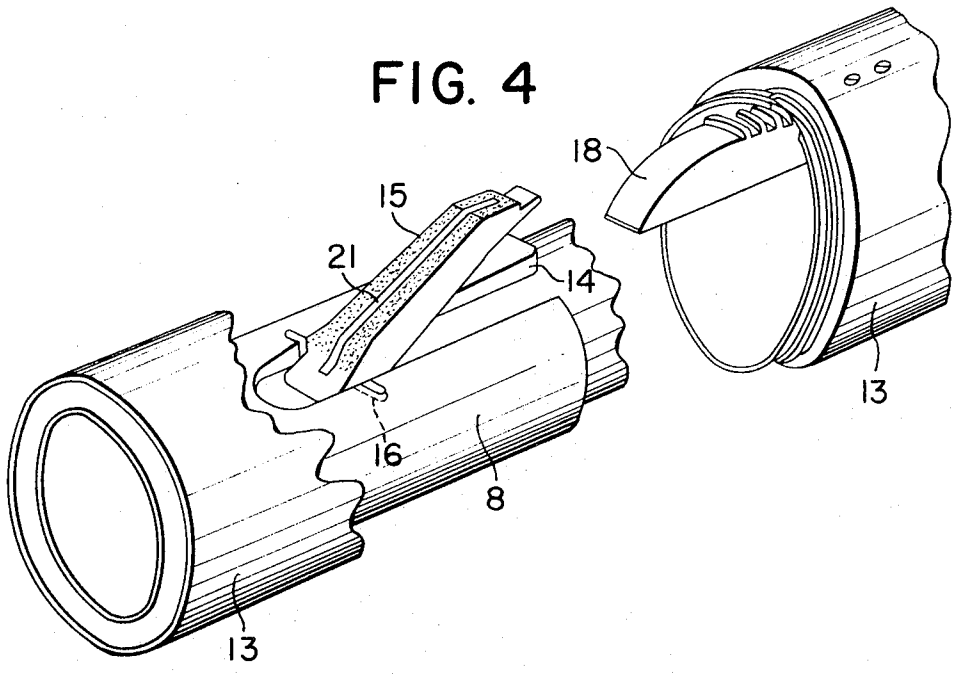

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FIG. 5

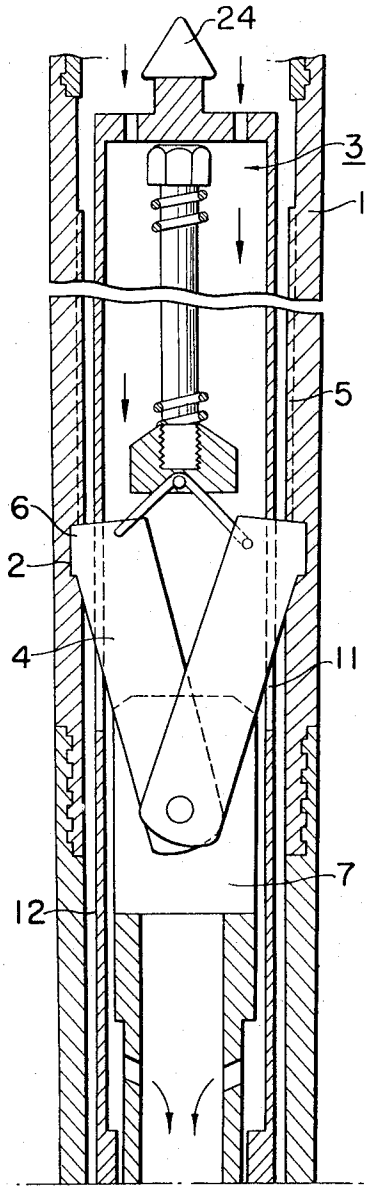
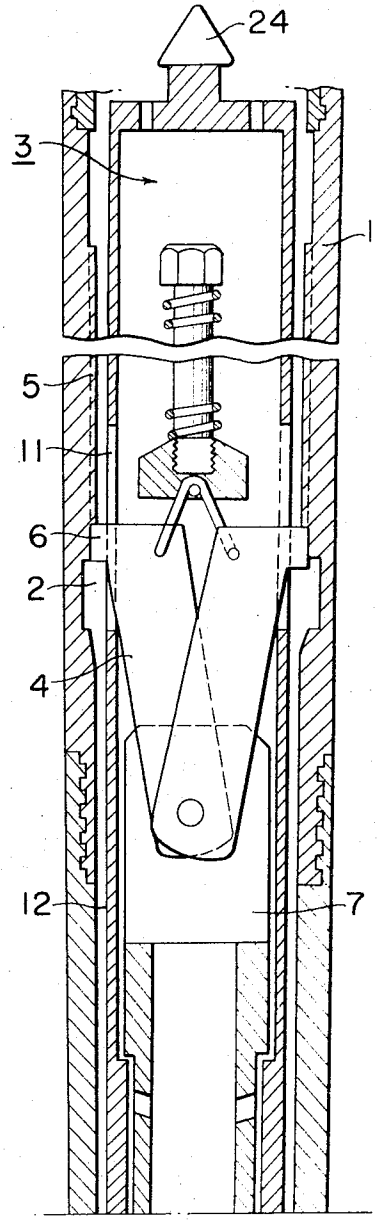


FIG. 6



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DRILLING SYSTEM

This invention relates to a drilling to be used for extracting ground samples from beneath ground level. It is practiced that an annular bit is fitted on to the tip of a drill stem consisting of pipes and is lowered into the ground while being rotated so that a columnar core may be cut and taken into the bit and may be thus taken out on the ground. There is known a drilling system of a structure wherein a core tube can be inserted and taken out through the drill stem so that only the core may be removed after drilling without taking the bit and drill stem propelled into the ground.

A latching device is integrally provided in this type or core tube so as to be engaged with a recess made at the lower end of the drill stem so that the core tube may be prevented from being floated up toward the ground surface by the entry of a core into the core tube and to be disengaged in the event it is to be pulled up.

Now, if such latching device is so made as to be engaged with the drill stem in the axial direction and peripheral direction as the rotation and the propelling force into the ground of the drill stem are transmitted to the latching device, when a bit and a reaming device are fitted to the lower end of the latching device, the drill stem can be advanced together with the bit by reaming the hole with the reaming device while cutting and producing a core with the bit. However, usually, the length of the core to be cut and taken is about 3 meters, with the core tube being longer than the core. The rotating and propelling forces of the drill stem are to be transmitted from the latching device to the core tube and then from the core tube to the bit and therefore the movement of the tip of the bit is apt to become unstable.

Therefore, the present invention is to provide a drilling system provided with a latching device so that the apparatus may be inserted and pulled up through a drill stem wherein the latching device is provided integrally with a bit and a reaming device, is projected out of the lower end of the drill stem and is engaged with the drill stem so that the rotating force and propelling force of the drill stem may be transmitted directly to the bit and the blades of the reaming device from the lower end of the drill stem whereby a stable boring may be made.

According to the present invention, in order to attain this object, the lower end side of a member holding latching pawls of a latching device is cylindrical in shape so as to be able to project out of the lower end of a drill stem in the latching position, a bit is fitted to its tip, reaming blades are provided so as to be able to be opened and closed in the radial direction near such bit, cuts fitting these reaming blades in the axial direction and peripheral direction from the lower end of the drill stem are provided, the lower end of the member for closing the latching pawls of the latching device is extended to the reaming blades so that the reaming blade opening and closing operation may be possible and the latching device, the bit and the extension of the latching device to the reaming blades are formed so as to be engaged immovably to the underground side and ground surface side and engageable inside the drill stem.

In the accompanying drawings:

FIG. 1 is a vertical sectional view of an essential part of the present invention shown in its condition at the time of drilling:

FIG. 2 is a view similar to FIG. 1 except that the bit for cutting and taking a core and reaming blades are pulled up as compared to the FIG. 1 showing:

FIG. 3 is a partial perspective view of a reaming blade folding mechanism part:

FIG. 4 is a partial perspective view of a reaming blade opening mechanism part:

FIG. 5 is a vertical sectional view of a latching device adapter usable with the FIG. 1 device:

FIG. 6 is a vertical sectional view showing the latching device shown in FIG. 5 above the bit in the condition of FIG. 2.

The drilling system of the present invention will be described with reference to the embodiment illustrated in the drawings. The latching device shown in FIGS. 5 and 6 utilizes a known device. Therefore, the detailed explanation of the other parts than those relating to the apparatus of the present invention will be omitted. FIG. 6 shows a latching device 3 as lowered adjacent a latching recess 2 of a drill stem 1 from the ground surface side. Latching pawls 4 are disposed within guide grooves 5 provided on the inner surface of the drill stem 1. The pawls may be lowered, as shown, under force until they become fixed within latching recess 2, as shown in FIG. 5. The pawl parts 6 of the latching pawls 4 fit in the latching recess 2 so as to be immovable to the ground surface side and underground side.

The lower end side 8 of the member 7 to which latching pawls 4 are mounted is cylindrical in cross-section. As shown in FIG. 2, the lower end side 8 is of such a length as to project out of the lower end 9 of the drill stem 1 when the pawl parts 6 of the latching pawls 4 fit within the latching recess 2. To the end part of the lower end side 8 is fitted an annular bit 10 for cutting and taking a core of an outside diameter smaller than the inside diameter of the drill stem 1. The lower end 13 of an outer tube 12 with windows 11 provided adjacent latching pawls 4 to effect closing thereof as shown in FIG. 6, also projects beyond lower end 9 of drill stem 1 and extends near the bit 10, as shown in FIG. 2.

Axial concave grooves 14, as shown in FIG. 4, are provided on the outer surface of lower end side 8. A reaming blade 15 is disposed near bit 10 within groove 14 and is provided with a pin 16 at one end so as to facilitate movement thereof in a radial direction. A plate spring 17, disposed at the bottom of concave groove 14, serves to bias blade 15 open in a radial direction using the pin 16 as a fulcrum.

The lower end 13 of outer tube 12 is maintained in contact with the periphery of lower and side 8 of member 7 and is provided with windows 18 through which reaming blades 15 may open in a radial direction. On the ground surface side of these windows 18, as shown in FIG. 4, a projecting piece 19 extending toward the bit 10 is provided integrally with outer tube 12 so as to be in concave groove 14 of member 8. Inside the bit 10 side of the window 18, as shown in FIG. 3, an axial rib 20 is provided so that its top surface may contact the bottom of a longitudinal groove 21 provided along blade 15.

When the outer tube 12 moves toward the ground surface relative to latching pawls 4 as in FIG. 6, the lower end 13 is also in the elevated position as shown in FIG. 2, the top surface of rib 20 enters the longitudinal groove 21 of latching blade 15 thereof bottom, thereby pressing as in FIG. 3 plate spring 17 to force reaming blade 15 in the concave groove 14, as shown in FIG. 2. At such time, the projecting piece 19 is positioned on the ground surface side away from reaming blade 15. When reaming blade 15 is forced into concave groove 14, the outer surface thereof is within the inner surface of the drill stem 1.

When the outer tube 12 lowers and, as shown in FIG. 5, the upper edge of the window 11 presses against latching pawl 4 until the parts 6 thereof engage with groove 2, the rib 20 of outer tube 12 moves to the bit 10 side and separates from the reaming blade 15, nothing presses reaming blade 15, therefore reaming blade 15 opens radially outward at the upper end with the pin 16 as a fulcrum and, at the same time, the projecting piece 19 also lowers to push the reaming blades 15 from their inner side to an open condition as shown in FIG. 1. When the reaming blade 15 is opened, both side surfaces thereof fit between each axial side surface of an axial opening 22 provided in lower end 9 of drill stem 1 and, at the same time, the free end of reaming blade 15 mates with the bottom 23 of the cut 22.

Therefore, the rotation of drill stem 1 is transmitted from the side surface of opening 22 to reaming blade 15 and from reaming blade 15 to the lower end side 8 of member 7 and thus to the bit 10 fitted at the end of lower end side 8. Further, the propelling force toward the ground beneath drill stem 1 is transmitted from bottom 23 of the cut 22 to reaming blade 15, from the reaming blade to lower end side 8, and from lower end side 8 to bit 10.

Thus the rotating and propelling forces of the drill stem are transmitted to the bit and reaming blades in a short distance and therefore the boring can be made stably in the correct direction. Since the outside diameter of bit **10** is smaller than the inside diameter of the drill stem thereby making it possible to insert bit **10** through drill stem **1**, the bore is reamed by means of boring blades **15** so as to be large enough to propel the drill stem through it.

A well known core tube and core cutting and taking device is provided on the lower end side **8** of the member **7**. After the core which is cut and taken with the bit **10**, becomes sufficiently long within the core tube and, when a lifting head part **24** of latching device **3** is elevated to the ground surface in the normal manner, outer tube **12** is therefore pulled up first, the projecting piece **19** rises and, at the same, the rib **20** enters longitudinal groove **21** of reaming blade **15** and the reaming blades **15** are closed from the condition shown in FIG. **1** to that of FIG. **2**. Then, the lifted outer tube **12** disengages latching pawl **4** from latching recess **2** as the lower edges of windows **11** abut against the edges of pawl parts **4**. When it is further pulled up, reaming blades **15** connected with latching device **3** and bit **10** can be pulled up integrally toward the ground surface.

In the above explained embodiment, the apparatus is latched on both underground side and ground surface side with the latching pawls **15**. However, it may be latched on the ground surface side with the latching pawls and on the underground side with the inside of the drill stem and the outer tube **12**. Structures other than specifically shown in this embodiment can also be used for the structure of the latching device.

In this embodiment, the member holding the latching pawls is provided inside the outer tube **12**. However, in the event the latching pawls are to be mounted on a tube provided outwardly of outer tube **12**, the tube for opening and closing the reaming blades and for opening the latching pawls may be positioned inside. Further, the reaming blades are opened and closed by the upward and downward movements of the windows **18** of the outer tube **12** in the present embodiment but can also be formed to be operated by either of the upward and downward movements.

As in the above, according to the apparatus of the present invention, not only the core tube as before but also the bit and reaming blades can be removed on the ground without pulling up the drill stem and therefore not only the bit and reaming blades can be easily replaced but also the rotating and propelling forces of the drill stem can be stably transmitted to the bit and reaming blades and the test-boring can be made in the correct direction. It is a simple matter to replace the bit for cutting and taking a core with a bit only for boring.

What is claimed is:

1. A drilling apparatus comprising a hollow drill stem provided with an annular groove along its inner surface, an outer hollow tube disposed for longitudinal movement within said stem, an inner hollow tube disposed for longitudinal movement within said outer tube, latching pawl members mounted on said inner tube for movement toward and away from said drill stem inner surface, arm means at one end of said pawl members provided for mating and locking engagement with said annular groove, a drill bit provided at the lower end of said inner tube, the longitudinal extent of said inner tube being such that said bit is disposed longitudinally outwardly of the lower end of said stem, first longitudinal openings in the wall of said outer tube through which said pawl members project for engagement with said groove, said outer tube at one end of said first openings serving to move said pawl members away from said stem out of engagement with said groove during upward movement of said outer tube, reaming blades disposed near said drill bit and being mounted at one end thereof on said inner tube for movement in a radial direction away from and toward said inner tube, each said reaming blade one end being disposed nearest said drill bit with respect to the remaining portion of each said blade, said outer tube being provided with second longitudinal openings in said wall thereof in the vicinity of said blades, said stem being provided with third longitudinal openings in the vicinity of said second openings, means on said inner tube for moving said blades radially outwardly through said second and third openings when said inner tube is in a latching position with said pawl members in engagement with said groove, and said outer tube at one end of said second opening cooperating with said blades to move same radially inwardly during the upward movement of said outer tube and, said a further upward movement of said outer tube, said one ends of said first openings engaging said arm means whereby said pawl members, said bit, said inner tubes and said blades are upwardly movable together with said further upward movement of said outer tube.

2. The apparatus according to claim **1** wherein means are provided on said outer tube for engaging behind said blades after they have moved radially outwardly, thereby preventing inward movement thereof while said inner tube is in its latching position.

3. The apparatus according to claim **1** wherein said pawl members are pivotally mounted at one end extending toward said bit with the other ends of said pawl members extending upwardly.

4. The apparatus according to claim **1** wherein inwardly extending ribs are provided on said outer tube at said one end of said second opening, and each said blade is provided with a longitudinal groove for cooperation with each said rib for movement of said blades radially inwardly during the upward movement of said outer tube.

5. The apparatus according to claim **1** wherein said blade moving means comprise plate springs for each said blade.

6. The apparatus according to claim **1** wherein a hollow sampling tube is provided for longitudinal movement within said inner tube and being so disposed as to be removable therewith upon the further upward movement of said outer tube.

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