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RAPID ASSEMBLY AND AUTOMATIC SAMPLING DRILLING TOOL FOR FROZEN SOIL LAYER EXPLORATION

Abstract

A rapid assembly and automatic sampling drilling tool for frozen soil layer exploration includes a fixed flow divider, a flow guide pipe, a coring pipe and a drill bit. The fixed flow divider is connected to the drill bit through the flow guide pipe and the coring pipe mounted between the fixed flow divider and the drill bit. Two ends of the flow guide pipe communicate with the fixed flow divider and a main flow channel in the drill bit respectively. Hot water in the fixed flow divider can be conveyed into the drill bit through the flow guide pipe and sprayed from a nozzle arranged on the drill bit for drilling and coring operations. An inlet of the coring pipe communicates with a coring channel in an inner cavity in the drill bit, and a core sample drilled by the drill bit is taken out through the coring pipe.

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Background/Summary

FIELD OF THE INVENTION

[0001] The present invention relates to an automatic sampling drilling tool, particularly to a rapid assembly and automatic sampling drilling tool for frozen soil layer exploration.

BACKGROUND OF THE INVENTION

[0002] Presently, with the rapid development of economy, the construction of various major projects has gradually expanded from the mainland region to plateau and high-cold regions. It is very challenging to carry out preliminary exploration work in such extreme environments; the reason is that the permafrost formed in a low-temperature environment has extremely special engineering geological properties, and its physical and mechanical properties are different from those of ordinary soil layers. In addition, the active layer in the permafrost area freezes and melts seasonally every year. One of the main means of permafrost exploration is to obtain permafrost samples by drilling. The current conventional drilling method is to break core samples using the breaker inside the drill bit after completion of drilling, and then pull the samples to the earth surface together with the drilling tool. When this method is used, the friction generated by the rotation of the drill bit increases the temperature of the breaker, and the higher temperature of the breaker melts part of the permafrost layer, which makes the core breaking function of the breaker to become ineffective and results in the failure to acquire some core samples during drilling. Another drilling method is the hot water drilling method in ice drilling, which uses the jetted hot water to melt the frozen soil layer to complete the drilling; the method has the characteristics of no drilling fluid pollution and rapid drilling, etc. It can complete coring from the frozen soil layer at certain specific depths, and there is no need of coring from all of them. Therefore, it is more efficient and convenient in application. Based on this method, a rapid assembly and automatic sampling drilling tool is designed, which can effectively solve the problems of failure of the function of a breaker in a rotary drilling method and difficulty in recovering ice cores on the earth surface in a thermal melt drilling method, etc., improve the drilling efficiency of frozen soil layers greatly, and further improve the exploration technology of frozen soil layers.

SUMMARY OF THE INVENTION

[0003] An object of the present invention is to provide a rapid assembly and automatic sampling drilling tool for frozen soil layer exploration, to effectively solve a plurality of problems such as a failure of the function of a breaker in a rotary drilling method and difficulty in recovering ice cores on the earth surface in a thermal melt drilling method.

[0004] The rapid assembly and automatic sampling drilling tool for frozen soil layer exploration provided in the present invention includes a fixed flow divider, a flow guide pipe, a coring pipe and a drill bit. The fixed flow divider is connected to the drill bit through the flow guide pipe and the coring pipe, the flow guide pipe and the coring pipe are mounted between the fixed flow divider and the drill bit, two ends of the flow guide pipe are in communication with the fixed flow divider and a main flow channel in the drill bit respectively, hot water in the fixed flow divider can be conveyed into the drill bit through the flow guide pipe and sprayed from a nozzle arranged on the

drill bit for drilling and coring operations, an inlet of the coring pipe is in communication with a coring channel in an inner cavity in the middle of the drill bit, and a core sample drilled by the drill bit is taken out through the coring pipe.

[0005] The coring pipe is a plexiglass pipe, four flow guide pipes are provided, and the four flow guide pipes are arranged around the coring pipe, the flow guide pipes are connected to the drill bit by a quick connector, and the flow guide pipes and the drill bit can be quickly disassembled through the quick connector, and a breaker is mounted at a junction between the drill bit and the inlet of the coring pipe for breaking the core sample drilled by the drill bit.

[0006] The drill bit is a ring structure, the drill bit is composed of an inner ring and an outer ring, the outer ring is sleeved on the lower part of the inner ring, the top of the inner ring is equipped with a male end of the quick connector, and the top of the inner ring can be fixedly connected with a female end of the quick connector assembled at the bottom of the flow guide pipe through the male end of the quick connector, a plurality of connecting ear plates are arranged around the lower part of the inner ring, positioning bolts are arranged on the connecting ear plates in a penetrating manner, the inner ring is connected to the outer ring through the positioning bolts, a reset spring is sleeved on the positioning bolts below the connecting ear plates, and the outer ring can move along the axial direction of the positioning bolts as the reset spring extends and retracts.

[0007] Both the inner ring and the outer ring are hollow structures, the inner cavities of the outer ring and the inner ring are set as coring channels, a circulation channel is formed between the outer wall and the bottom of the inner ring and the inner wall and the bottom of the outer ring, a vertical main flow channel is formed in the side wall of the inner ring, an inlet at the upper end of the main flow channel is in communication with an outlet of the flow guide pipe, the main flow channel is used as a passage of hot water in the fixed flow divider, an outlet at the bottom of the main flow channel is in communication with the circulation channel formed between the inner ring and the outer ring, a water supply nozzle is provided on the side wall of the main flow channel corresponding to the inner cavity of the inner ring, and two ends of the water supply nozzle are in communication with the main flow channel and the circulation channel respectively, a first seal ring is mounted on the upper part of the water supply nozzle in the circulation channel, a second seal ring and a third seal ring are mounted sequentially on the lower part of the water supply nozzle in the circulation channel, a plurality of coring nozzles are provided around the side wall of the outer ring between the first seal ring and the third seal ring, and the coring nozzles can be in communication with the water supply nozzle through the circulation channel, a fourth seal ring is mounted in the other side of the circulation channel corresponding to the third seal ring, a drilling nozzle is provided at the bottom of the outer ring, a fifth seal ring is mounted at the bottom of the inner ring, and the fifth seal ring is arranged corresponding to the drilling nozzle, when the outer ring moves to the farthest end for drilling operation under the action of gravity and the tension of the reset spring, the first seal ring, the second seal ring, the third seal ring and the fourth seal ring seal the passage between the water supply nozzle and the coring nozzle and the main flow channel and the circulation channel respectively so that the hot water in the main flow channel is sprayed through the drilling nozzle for drilling operation; when coring to the set position, the outer ring moves up and fits tightly against the bottom of the inner ring, the first seal ring, the second seal ring, the third seal ring and the fourth seal ring seal the circulation channel, the fifth seal ring seals the drilling nozzle, the water supply nozzle is in communication with the coring nozzle through the circulation channel, and the hot water in the main flow channel is sprayed through the coring nozzle for coring operation.

[0008] The fixed flow divider, the quick connector and the breaker are all assemblies of existing equipment, so the specific models and specifications are not described in detail.

[0009] The working principle of the present invention is as follows:

[0010] When the rapid assembly and automatic sampling drilling tool for frozen soil layer exploration provided by the present invention starts drilling, the drilling tool is lowered vertically

to the borehole, and the outer ring of the drill bit moves to the farthest end under the action of gravity and the tension of the reset spring to form a drilling state. In this state, hot water enters from the inlet of the fixed flow divider, flows through the flow guide pipe, and then merges in the main flow channel in the side wall of the inner ring of the drill bit. At this time, the first seal ring and the second seal ring seal the water flow channel of the water supply nozzle, the third seal ring seals the water flow channel of the coring nozzle, and the fourth seal ring seals the circulation channel between the inner ring and the outer ring; hot water is sprayed from the drilling nozzle at the bottom of the outer ring to melt the frozen soil layer for drilling, and the formed core samples enter the coring pipe.

[0011] As drilling progresses, the coring pipe is filled with core samples gradually; at this time, the drill bit is lowered continuously, and the outer ring of the drill bit begins to contact the bottom of the borehole. Under the thrust of the frozen soil layer at the bottom of the borehole, the outer ring overcomes gravity and the tension of the reset spring; the outer ring moves upward to be close to the bottom of the inner ring, forming a coring state. In this state, the water supply nozzle formed on the side wall of the inner ring is in communication with the coring nozzle formed on the side wall of the outer ring through the circulation channel. The first seal ring, the second seal ring, the third seal ring and the fourth seal ring seal the circulation channel between the inner ring and the outer ring, and the fifth seal ring seals the drilling nozzle at the bottom of the outer ring. At this time, hot water can flow from the water supply nozzle on the side wall of the inner ring into the coring nozzle on the side wall of the outer ring, which is sprayed to melt the core samples radially until the core samples are melted off.

[0012] After the core samples are melted off, the drilling tool is pulled up; core samples are supported by the breaker on the drill bit and moved to the earth surface along with the drilling tool; at this time, the quick connector is manually opened, the drill bit can be quickly removed, the coring pipe containing the core samples is pulled out, and the core samples are recovered, and one round of drilling is completed. The coring pipe is cleaned and placed in the space surrounded by the flow guide pipe. Then the male and female ends of the quick connector are closed, the drill bit is connected with the flow guide pipe, and the coring pipe is fixed again to start the second drilling.

Beneficial Effects of the Present Invention

[0013] The rapid assembly and automatic sampling drilling tool for frozen soil layer exploration provided by the invention has a unique structural design and definite principle, and effectively solves a plurality of problems such as a failure of the function of a breaker in a rotary drilling method and difficulty in recovering ice cores on the earth surface in a thermal melt drilling method; furthermore, it can automatically change the internal water flow channel to melt the ice cores during drilling, and quickly disassemble to obtain core samples after completion of drilling, greatly improving the efficiency of drilling and auxiliary operations and effectively saving resources.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] FIG. **1** is an overall structural view of a drilling tool of the present invention.

[0015] FIG. **2** is a sectional view of a ring-shaped drill bit when the drilling tool of the present invention is in the drilling state.

[0016] FIG. **3** is a sectional view of a ring-shaped drill bit when the drilling tool of the present invention is in the coring state.

[0017] Reference numerals: **1**, fixed flow divider, **2**, flow guide pipe, **3**, coring pipe, **4**, drill bit, **5**, main flow channel, **6**, coring channel, **7**, quick connector, **8**, breaker, **9**, inner ring, **10**, outer ring, **11**, connecting ear plate, **12**, positioning bolt, **13**, reset spring, **14**, circulation channel, **15**, water supply nozzle, **16**, first seal ring, **17**, second seal ring, **18**, third seal ring, **19**, coring nozzle, **20**,

fourth seal ring, **21**, drilling nozzle, **22**, fifth seal ring.

DETAILED DESCRIPTION

[0018] Please refer to FIG. **1** to FIG. **3**.

[0019] The rapid assembly and automatic sampling drilling tool for frozen soil layer exploration provided in the present invention includes a fixed flow divider **1**, a flow guide pipe **2**, a coring pipe **3** and a drill bit **4**. The fixed flow divider **1** is connected to the drill bit **4** through the flow guide pipe **2** and the coring pipe **3**, the flow guide pipe **2** and the coring pipe **3** are mounted between the fixed flow divider **1** and the drill bit **4**, two ends of the flow guide pipe **2** are in communication with the fixed flow divider **1** and a main flow channel **5** in the drill bit **4** respectively, hot water in the fixed flow divider **1** can be conveyed into the drill bit **4** through the flow guide pipe **2** and sprayed from a nozzle arranged on the drill bit **4** for drilling and coring operations, an inlet of the coring pipe **3** is in communication with a coring channel **6** in an inner cavity in the middle of the drill bit **4**, and a core sample drilled by the drill bit **4** is taken out through the coring pipe **3**.

[0020] The coring pipe **3** is a plexiglass pipe, four flow guide pipes **2** are provided, and the four flow guide pipes **2** are arranged around the coring pipe **3**, the flow guide pipes **2** are connected to the drill bit **4** by a quick connector **7**, and the flow guide pipes **2** and the drill bit **4** can be quickly disassembled through the quick connector **7**, and a breaker **8** is mounted at a junction between the drill bit **4** and the inlet of the coring pipe **3** for breaking the core sample drilled by the drill bit **4**.

[0021] The drill bit **4** is a ring structure, the drill bit **4** is composed of an inner ring **9** and an outer ring **10**, the outer ring **10** is sleeved on the lower part of the inner ring **9**, the top of the inner ring **9** is equipped with a male end of the quick connector **7**, and the top of the inner ring **9** can be fixedly connected with a female end of the quick connector **7** assembled at the bottom of the flow guide pipe **2** through the male end of the quick connector **7**, a plurality of connecting ear plates **11** are arranged around the lower part of the inner ring **9**, positioning bolts **12** are arranged on the connecting ear plates **11** in a penetrating manner, the inner ring **9** is connected to the outer ring **10** through the positioning bolts **12**, a reset spring **13** is sleeved on the positioning bolts **12** below the connecting ear plates **11**, and the outer ring **10** can move along the axial direction of the positioning bolts **12** as the reset spring **13** extends and retracts.

[0022] Both the inner ring **9** and the outer ring **10** are hollow structures, the inner cavities of the outer ring **10** and the inner ring **9** are set as coring channels **16**, a circulation channel **14** is formed between the outer wall and the bottom of the inner ring **9** and the inner wall and the bottom of the outer ring **10**, a vertical main flow channel **5** is formed in the side wall of the inner ring **9**, an inlet at the upper end of the main flow channel **5** is in communication with an outlet of the flow guide pipe **2**, the main flow channel **5** is used as a passage of hot water in the fixed flow divider **1**; an outlet at the bottom of the main flow channel **5** is in communication with the circulation channel **14** formed between the inner ring **9** and the outer ring **10**, a water supply nozzle **15** is provided on the side wall of the main flow channel **5** corresponding to the inner cavity of the inner ring **9**, and two ends of the water supply nozzle **15** are in communication with the main flow channel **5** and the circulation channel **14** respectively; a first seal ring **16** is mounted on the upper part of the water supply nozzle **15** in the circulation channel **14**, a second seal ring **17** and a third seal ring **18** are mounted sequentially on the lower part of the water supply nozzle **15** in the circulation channel **14**, a plurality of coring nozzles **19** are provided around the side wall of the outer ring **10** between the first seal ring **16** and the third seal ring **18**; and the coring nozzles **19** can be in communication with the water supply nozzle **15** through the circulation channel **14**, a fourth seal ring **20** is mounted in the other side of the circulation channel **14** corresponding to the third seal ring **18**, a drilling nozzle **21** is provided at the bottom of the outer ring **10**, a fifth seal ring **22** is mounted at the bottom of the inner ring **9**, and the fifth seal ring **22** is arranged corresponding to the drilling nozzle **21**; when the outer ring **10** moves to the farthest end for drilling operation under the action of gravity and the tension of the reset spring **13**, the first seal ring **16**, the second seal ring **17**, the third seal ring **18** and the fourth seal ring **20** seal the passage between the water supply nozzle **15** and the coring

nozzle **19** and the main flow channel **5** and the circulation channel **14** respectively, so that the hot water in the main flow channel **5** is sprayed through the drilling nozzle **21** for drilling operation; when coring to the set position, the outer ring **10** moves up and fits tightly against the bottom of the inner ring **9**, the first seal ring **16**, the second seal ring **17**, the third seal ring **18** and the fourth seal ring **20** seal the circulation channel **14**, the fifth seal ring **22** seals the drilling nozzle **21**, the water supply nozzle **15** is in communication with the coring nozzle **19** through the circulation channel **14**, and the hot water in the main flow channel **5** is sprayed through the coring nozzle **19** for coring operation.

[0023] The fixed flow divider **1**, the quick connector **7** and the breaker **8** are all assemblies of existing equipment, so the specific models and specifications are not described in detail.

[0024] The working principle of the present invention is as follows:

[0025] When the rapid assembly and automatic sampling drilling tool for frozen soil layer exploration provided by the present invention starts drilling, the drilling tool is lowered vertically to the borehole, and the outer ring **10** of the drill bit **4** moves to the farthest end under the action of gravity and the tension of the reset spring **13** to form a drilling state. In this state, hot water enters from the inlet of the fixed flow divider **1**, flows through the flow guide pipe **2**, and then merges in the main flow channel **5** in the side wall of the inner ring **9** of the drill bit **4**. At this time, the first seal ring **16** and the second seal ring **17** seal the water flow channel of the water supply nozzle **15**, the third seal ring **18** seals the water flow channel of the coring nozzle **19**, and the fourth seal ring **20** seals the circulation channel **14** between the inner ring **9** and the outer ring **10**; hot water is sprayed from the drilling nozzle **21** at the bottom of the outer ring **10** to melt the frozen soil layer for drilling, and the formed core samples enter the coring pipe **3**.

[0026] As drilling progresses, the coring pipe **3** is filled with core samples gradually; at this time, the drill bit is lowered continuously, and the outer ring **10** of the drill bit **4** begins to contact the bottom of the borehole. Under the thrust of the frozen soil layer at the bottom of the borehole, the outer ring **10** overcomes gravity and the tension of the reset spring **13**; the outer ring **10** moves upward to be close to the bottom of the inner ring **9**, forming a coring state. In this state, the water supply nozzle **5** formed on the side wall of the inner ring **9** is in communication with the coring nozzle **19** formed on the side wall of the outer ring **10** through the circulation channel **14**. The first seal ring **16**, the second seal ring **17**, the third seal ring **18** and the fourth seal ring **20** seal the circulation channel **14** between the inner ring **9** and the outer ring **10**, and the fifth seal ring **22** seals the drilling nozzle **21** at the bottom of the outer ring **10**. At this time, hot water can flow from the water supply nozzle **15** on the side wall of the inner ring **9** into the coring nozzle **19** on the side wall of the outer ring **10**, which is sprayed to melt the core samples radially until the core samples are melted off.

[0027] After the core samples are melted off, the drilling tool is pulled up; core samples are supported by the breaker **8** on the drill bit **4** and moved to the earth surface along with the drilling tool; at this time, the quick connector **7** is manually opened, the drill bit **4** can be quickly removed, the coring pipe **3** containing the core samples is pulled out, and the core samples are recovered, and one round of drilling is completed. The coring pipe **3** is cleaned and placed in the space surrounded by the flow guide pipe **2**. Then the male and female ends of the quick connector **7** are closed, the drill bit **4** is connected with the flow guide pipe **2**, and the coring pipe **3** is fixed again to start the second drilling.

Claims

1. A rapid assembly and automatic sampling drilling tool for frozen soil layer exploration, comprising a fixed flow divider, a flow guide pipe, a coring pipe and a drill bit, wherein the fixed flow divider is connected to the drill bit through the flow guide pipe and the coring pipe, the flow guide pipe and the coring pipe are mounted between the fixed flow divider and the drill bit, two

ends of the flow guide pipe are in communication with the fixed flow divider and a main flow channel in the drill bit respectively, hot water in the fixed flow divider can be conveyed into the drill bit through the flow guide pipe and sprayed from a nozzle arranged on the drill bit for drilling and coring operations, an inlet of the coring pipe is in communication with a coring channel in an inner cavity in the middle of the drill bit, and a core sample drilled by the drill bit is taken out through the coring pipe.

2. The rapid assembly and automatic sampling drilling tool for frozen soil layer exploration according to claim 1, wherein the coring pipe is a plexiglass pipe, four flow guide pipes are provided, and the four flow guide pipes are arranged around the coring pipe, the flow guide pipes are connected to the drill bit by a quick connector, and the flow guide pipes and the drill bit can be quickly disassembled through the quick connector, and a breaker is mounted at a junction between the drill bit and the inlet of the coring pipe for breaking the core sample drilled by the drill bit.

3. The rapid assembly and automatic sampling drilling tool for frozen soil layer exploration according to claim 1, wherein the drill bit is a ring structure, the drill bit is composed of an inner ring and an outer ring, the outer ring is sleeved on the lower part of the inner ring, the top of the inner ring is equipped with a male end of the quick connector, and the top of the inner ring can be fixedly connected with a female end of the quick connector assembled at the bottom of the flow guide pipe through the male end of the quick connector, a plurality of connecting ear plates are arranged around the lower part of the inner ring, positioning bolts are arranged on the connecting ear plates in a penetrating manner, the inner ring is connected to the outer ring through the positioning bolts, a reset spring is sleeved on the positioning bolts below the connecting ear plates, and the outer ring can move along the axial direction of the positioning bolts as the reset spring extends and retracts.

4. The rapid assembly and automatic sampling drilling tool for frozen soil layer exploration according to claim 3, wherein both the inner ring and the outer ring are hollow structures, the inner cavities of the outer ring and the inner ring are set as coring channels, a circulation channel is formed between the outer wall and the bottom of the inner ring and the inner wall and the bottom of the outer ring, a vertical main flow channel is formed in the side wall of the inner ring, an inlet at the upper end of the main flow channel is in communication with an outlet of the flow guide pipe, the main flow channel is used as a passage of hot water in the fixed flow divider, an outlet at the bottom of the main flow channel is in communication with the circulation channel formed between the inner ring and the outer ring, a water supply nozzle is provided on the side wall of the main flow channel corresponding to the inner cavity of the inner ring, and two ends of the water supply nozzle are in communication with the main flow channel and the circulation channel respectively, a first seal ring is mounted on the upper part of the water supply nozzle in the circulation channel, a second seal ring and a third seal ring are mounted sequentially on the lower part of the water supply nozzle in the circulation channel, a plurality of coring nozzles are provided around the side wall of the outer ring between the first seal ring and the third seal ring, and the coring nozzles can be in communication with the water supply nozzle through the circulation channel, a fourth seal ring is mounted in the other side of the circulation channel corresponding to the third seal ring, a drilling nozzle is provided at the bottom of the outer ring, a fifth seal ring is mounted at the bottom of the inner ring, and the fifth seal ring is arranged corresponding to the drilling nozzle, when the outer ring moves to the farthest end for drilling operation under the action of gravity and the tension of the reset spring, the first seal ring, the second seal ring, the third seal ring and the fourth seal ring seal the passage between the water supply nozzle and the coring nozzle and the main flow channel and the circulation channel respectively so that the hot water in the main flow channel is sprayed through the drilling nozzle for drilling operation; when coring to the set position, the outer ring moves up and fits tightly against the bottom of the inner ring, the first seal ring, the second seal ring, the third seal ring and the fourth seal ring seal the circulation channel, the fifth seal ring seals the drilling nozzle, the water supply nozzle is in communication with the coring nozzle through the

circulation channel, and the hot water in the main flow channel is sprayed through the coring nozzle for coring operation.