

Description

SLURRY BALANCE AND DUAL-SHIELD DUAL-MODE SHIELD MACHINE

This application claims the priority of Chinese patent application No. 202311053561.3, filed with the Chinese Patent Office on August 21, 2023, and entitled “Slurry Balance and Dual-Shield Dual-Mode Shield Machine”, which is hereby incorporated by reference in its entirety.

TECHNICAL FIELD

The present application relates to the technical field of shield machines, and more specifically, to a slurry balance and dual-shield dual-mode shield machine.

BACKGROUND

Full-face tunnel boring machines generally include rock tunnel boring machines for rock strata and shield machines for soft soil strata. Existing rock tunnel boring machines and shield machines include various types. Rock tunnel boring machines include an open type, a single-shield type, a dual-shield type, and other types. Shield machines include a cutting type, a pneumatic pressure type, an earth pressure balance type, a slurry balance type, and other types. The principles of different types of tunnel boring machines and shield machines are not exactly the same, and they are suitable for different stratigraphic structures. Rock tunnel boring machines and shield machines are collectively referred to as shield machines in the prior art, and are also collectively referred to as shield machines or tunnel boring machines in the present application.

Dual-shield tunnel boring machines are usually used for excavating long-distance mountain tunnels. A dual-shield tunnel boring machine is of a semi-open type, provided with two arc-shaped bracing plates between its front shield and rear shield, which can be extended and retracted by means of an oil cylinder, and function to be pressed against an excavated rock layer after being extended out to provide a counterforce for a cutter head to perform excavation and for the front shield to advance. In this way, the front shield continues to advance through extension and contraction of an oil cylinder of a telescopic shield, while the rear shield remains

stationary, and pre-fabricated segments are synchronously assembled in an annular manner within the rear shield. Its main design concept lies in the synchronization of advancement and assembly. A reacting force for a push force is provided by a frictional force generated by support of the radial oil cylinder in the middle. A space formed by the cutter head and an inner cavity of the front shield of the dual-shield tunnel boring machine is a muck chamber. A belt conveyor or other muck discharge equipment extends into the muck chamber and transports muck formed by cutting the rock layer on an excavation face by the cutter head to the ground. The dual-shield tunnel boring machine provides relatively high construction efficiency, but due to its long length and incomplete sealing, it is not suitable for use in urban subway construction with mostly clay or sand layers.

A slurry balance shield machine is provided with a closing division plate on a back side of a cutter head of a mechanical shield, with a space between the closing division plate, an inner cavity of the front shield, and the cutter head serving as a slurry chamber. Slurry formed by mixing water, clay and additives is pressed into the slurry chamber through a conveying pipeline, and a slurry pressure chamber is formed when the slurry is filled into the whole slurry chamber and has a certain pressure. The steadiness of an excavation working face can be maintained by a pressurizing effect of the slurry and a pressure maintaining mechanism. When the shield advances, soil and sand cut down by the rotating cutter head are stirred by a stirring device to form high-concentration slurry, which is transported to a ground slurry separation system by fluid transportation, and transported back to the slurry chamber after muck and water are separated. This is a main feature of a slurry-pressurized balance shield method. Because the slurry pressure makes the excavation face steady and balanced, it is named a slurry-pressurized balance shield, or called a slurry balance shield for short. It can stabilize the excavation face in strata prone to quicksand, and may carry out construction operation under normal atmospheric pressure, is suitable for strata such as a soft silty clay layer, a loose sand soil layer, a gravel layer, pebble layer and hard soil interlayer, etc., and is especially suitable for high-water-content strata and trans-river tunnels and undersea tunnels with a water body above. The slurry balance shield machine can maintain the steadiness of the excavation face more accurately. However, because a tunneling push force originates from a counterforce of an auxiliary cylinder pushing against segments, advancement and assembly cannot be synchronized, and the construction

efficiency is low.

In order to improve the geologic adaptability of shield machines, provide high efficiency in construction and reduce the construction cost, dual-mode or multi-mode shield machines that integrate different types of shield machines have emerged in recent years. However, slurry balance shield machines need to be pressure-sealed internally, while dual-shield shield machines are of an open or semi-open structure. They are structurally contradictory, making it difficult to integrate slurry balance and dual-shield in a same shield machine.

SUMMARY OF THE INVENTION

The present application is proposed in view of this.

An object of the present application is to provide a slurry balance and dual-shield dual-mode shield machine.

The present application provides the following technical solutions:

A slurry balance and dual-shield dual-mode shield machine including:

a front shield, having a front shield cylinder housing;

a telescopic shield, having a telescopic cylinder housing, wherein the front shield cylinder housing is slidably sleeved on the telescopic cylinder housing, and one of an inner wall of the front shield cylinder housing and an outer wall of the telescopic cylinder housing is provided with a first sealing member, which is configured to tightly seal a gap between the inner wall of the front shield cylinder housing and the outer wall of the telescopic cylinder housing;

a bracing shield, connected to the telescopic shield, the bracing shield having a bracing cylinder housing and a bracing shoe mechanism, wherein the bracing cylinder housing has an opening, and the bracing shoe mechanism includes a bracing plate, and the bracing shoe mechanism is configured to extend the bracing plate out of the opening or retract the bracing plate into the opening; and

a central movable platform located on an inner side of both the front shield and the telescopic shield, the central movable platform including a central movable platform sealing housing and a closing division plate, wherein the central movable platform sealing housing is connected to the front shield by a movable mechanism; the closing division plate is provided at an end of the central movable platform sealing housing; and the movable mechanism is

configured to perform telescopic movement to cause the closing division plate to move to a first position which is close to a cutter head or a second position which is close to the telescopic shield, wherein in a state where the closing division plate has moved integrally to the first position in the direction towards the cutter head, a non-closed muck chamber is formed between an inner cavity of the front shield and the cutter head provided on the front shield; and in a state where the closing division plate has moved integrally to the second position in the direction towards the bracing shield, a slurry chamber closed in a slurry balance mode is formed between the closing division plate, the inner cavity of the front shield and the cutter head provided on the front shield, wherein

the slurry balance and dual-shield dual-mode shield machine has a dual-shield mode and the slurry balance mode, wherein in the dual-shield mode, the bracing shoe mechanism extends out the bracing plate so that the bracing plate is supported on rock, and the movable mechanism drives the closing division plate to move to the first position, and in the slurry balance mode, the bracing shoe mechanism retracts the bracing plate into the opening to close the opening, and the movable mechanism drives the closing division plate to move to the second position.

Optionally, the inner wall of the front shield cylinder housing is provided with a second sealing fit ring that protrudes therefrom;

an end of the telescopic cylinder housing is provided with a second sealing fit flange;

one of the second sealing fit ring and the second sealing fit flange is provided with a second sealing member; and

in the slurry balance mode, the telescopic shield retracts into place, and in a state where the telescopic cylinder housing has extended into the front shield cylinder housing to a limit position, the second sealing member is configured to tightly seal a gap between the second sealing fit flange and the second sealing fit ring.

Optionally, the slurry balance and dual-shield dual-mode shield machine includes fasteners, wherein

one of the central movable platform sealing housing and the third sealing fit housing is provided with a third sealing member;

the third sealing member is provided in a manner of extending along a circumference of an inner wall of the third sealing fit housing or along a circumference of an outer wall of the

central movable platform sealing housing;

the third sealing member is fixedly connected to the central movable platform sealing housing or the third sealing fit housing by means of fixing members, one end of each fixing member being passed through the third sealing member; and

the third sealing member is configured to seal a gap between the central movable platform sealing housing and the third sealing fit housing.

Optionally, an outer wall of the third sealing fit housing of the front shield is provided with a fourth sealing flange;

one of an edge of the closing division plate and the fourth sealing flange is provided with a fourth sealing member; and

in the slurry balance mode, in a state where the central movable platform has moved integrally to a limit position (a second position) in the direction towards the bracing shield, the fourth sealing member seals a gap between the closing division plate and the fourth sealing flange, and the slurry chamber is formed by a space between the closing division plate, the inner cavity of the front shield, and the cutter head.

Optionally, at least one of an inner wall of the opening of the bracing cylinder housing and a circumferential edge of the bracing plate is provided with a fifth sealing member; and

in the slurry balance mode, in a state where the bracing plate has retracted into the opening, the fifth sealing member seals a gap between the bracing plate and the bracing cylinder housing.

Optionally, the fifth sealing member is provided in a manner of extending along a circumference of the inner wall of the opening or along a circumference of the circumferential edge of the bracing plate;

the fifth sealing member is fixedly connected to the inner wall of the opening of the bracing cylinder housing or the circumferential edge of the bracing plate by means of fixing members, one end of each fixing member being passed through the fifth sealing member; and

in a state where the bracing plate has retracted into the opening, the fifth sealing member is compressed between the bracing plate and the inner wall of the opening.

Optionally, a sixth sealing fit ring is provided on an inner side of the bracing cylinder housing;

an inner edge of the sixth sealing fit ring extends towards a central axis of the opening;

and

in the slurry balance mode, the bracing plate retracts into the opening, and the bracing plate and the sixth sealing fit ring are in sealing fit with each other.

Optionally, the bracing plate is provided with an annular sixth sealing member on a side facing an inner side of the bracing cylinder housing; and

in the slurry balance mode, the bracing plate retracts into the opening, and the sixth sealing member tightly seals a gap between the bracing plate and the sixth sealing fit ring.

Optionally, the slurry balance and dual-shield dual-mode shield machine further includes an air bag member, wherein

the air bag member is provided on a surface of the bracing cylinder housing and the air bag member is arranged around a whole circumference of an edge of the opening, or the air bag member is provided on the bracing plate and the air bag member is arranged around a whole circumference of an edge of the bracing plate; and

in the slurry balance mode, the bracing plate retracts into the opening, and the air bag member covers and tightly seals a gap between the bracing plate and the bracing cylinder housing.

By adopting the above technical solutions, the present application achieves the following beneficial effects:

The dual-mode shield machine provided in the present application has the slurry balance mode and the dual-shield mode, enabling it to be suitable for tunneling construction in complex underground environments, so that it can be used for both construction in high-water-content soft and loose soil layers, and construction in soft rock and hard rock and very hard rock strata, thus significantly improving the geological adaptability and construction efficiency of the shield machine.

Specific embodiments of the present application are further described in detail below in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The drawings as a part of the present application are used to provide further understanding of the present application. Illustrative embodiments of the present application and description

thereof are used for explaining the present application, but do not improperly limit the present application. Obviously, the drawings described below only represent some embodiments, and those of ordinary skill in the art can obtain other drawings according to these drawings without creative work. In the drawings:

Fig. 1 is a cross-sectional view of a slurry balance and dual-shield dual-mode shield machine (dual-shield mode) provided in an embodiment of the present application;

Fig. 2 is a cross-sectional view of a slurry balance and dual-shield dual-mode shield machine (slurry balance mode) provided in an embodiment of the present application;

Fig. 3 is the sealing fit structure of a front shield cylinder housing and a telescopic cylinder housing in a slurry balance and dual-shield dual-mode shield machine provided in an embodiment of the present application;

Fig. 4 is an enlarged view of a part A in Fig. 3;

Fig. 5 is a schematic fit structure diagram of a third sealing fit housing of a front shield, a central movable platform sealing housing, and a closing division plate in a slurry balance and dual-shield dual-mode shield machine provided in an embodiment of the present application;

Fig. 6 is an enlarged view of a part D in Fig. 5;

Fig. 7 is an enlarged view of a part E in Fig. 5;

Fig. 8 is a schematic fit structure diagram of a bracing cylinder housing and a bracing shoe mechanism in a slurry balance and dual-shield dual-mode shield machine provided in an embodiment of the present application;

Fig. 9 is an enlarged view of a part B in Fig. 8;

Fig. 10 is an enlarged view of a part C in Fig. 8; and

Fig. 11 is a schematic structure diagram of providing an air bag member on a bracing plate in a slurry balance and dual-shield dual-mode shield machine provided in an embodiment of the present application.

Reference numerals: 1, front shield; 11, front shield cylinder housing; 12, second sealing fit ring; 13, third sealing fit housing; 131, fourth sealing flange; 2, telescopic shield; 21, telescopic cylinder housing; 22, second sealing fit flange; 3, bracing shield; 31, bracing cylinder housing; 311, sixth sealing fit ring; 32, bracing shoe mechanism; 321, bracing plate; 4, central movable platform; 41, closing division plate; 42, central movable platform sealing housing; 43,

movable mechanism; a, first sealing member; b, second sealing member; c, third sealing member; d, fourth sealing member; e, fifth sealing member; f, sixth sealing member; g, fastener; h, air bag member.

It is to be noted that these drawings and text description are not intended to limit the scope of conception of the present application in any way, but to explain the concepts of the present application for those skilled in the art by referring to specific embodiments.

DETAILED DESCRIPTION

To make the object, technical solutions and advantages of embodiments of the present invention clearer, the technical solutions in the embodiments will be described below clearly and completely with reference to the drawings in the embodiments of the present invention. The following embodiments are used for illustrating the present application, but not limiting the scope of the present application.

In description of the present application, it is to be noted that orientation or location relations denoted by the terms "upper", "lower", "inner", "outer", etc. are orientation or location relations based on illustration in the drawings, are only intended to facilitate describing the present application and simplify description, instead of indicating or implying the denoted devices or components necessarily have specific orientations and are constructed and operated in specific orientations, and thus they should not be construed as limiting the present application.

In description of the present application, it is to be noted that unless otherwise explicitly specified and defined, the terms "mount" and "connect" should be construed broadly. For example, such a term may denote fixed connection, or detachable connection, or integrated connection; mechanical connection, or electric connection; direct connection, or indirect connection via an intermediate medium. For those of ordinary skill in the art, specific meanings of the above-mentioned terms in the present application may be construed according to specific circumstances.

Referring to Figs. 1 to 11, embodiments of the present application provide a slurry balance and dual-shield dual-mode shield machine including: a front shield 1, a telescopic shield 2, a bracing shield 3, and a central movable platform 4. The front shield 1 has a front shield cylinder housing 11. The telescopic shield 2 has a telescopic cylinder housing 21. The front shield

cylinder housing 11 is slidably sleeved on the telescopic cylinder housing 21. One of an inner wall of the front shield cylinder housing 11 and an outer wall of the telescopic cylinder housing 21 is provided with a first sealing member a. The first sealing member a is configured to tightly seal a gap between the inner wall of the front shield cylinder housing 11 and the outer wall of the telescopic cylinder housing 21. The central movable platform 4 is located on an inner side of both the front shield 1 and the telescopic shield 2. The central movable platform 4 includes a central movable platform sealing housing 42, a closing division plate 41 and a movable mechanism 43. The central movable platform sealing housing 42 is connected to the front shield 1 by the movable mechanism 43. The closing division plate 41 is provided at an end of the central movable platform sealing housing 42. The movable mechanism 43 is configured to perform telescopic movement to cause the closing division plate 41 to move to a second position (as shown in Fig. 2) or a first position (as shown in Fig. 1). In a state where the closing division plate 41 has moved to the second position, a closed slurry chamber is formed between the closing division plate 41, an inner cavity of the front shield 1 and a cutter head provided on the front shield 1. In a state where the closing division plate 41 has moved to the first position, a closed muck chamber is formed between the closing division plate 41, the inner cavity of the front shield 1 and the cutter head provided on the front shield 1. The bracing shield 3 is connected to the telescopic shield 2. The bracing shield has a bracing cylinder housing 31 and a bracing shoe mechanism 32. The bracing cylinder housing 31 has an opening. The bracing shoe mechanism 32 includes a bracing plate 321. The bracing shoe mechanism 32 is configured to extend the bracing plate 321 out of the opening or retract the bracing plate into the opening.

The slurry balance and dual-shield dual-mode shield machine has a dual-shield mode and a slurry balance mode. In the dual-shield mode, the bracing shoe mechanism 32 extends out the bracing plate 321 so that the bracing plate is supported on rock, and the movable mechanism 43 drives the closing division plate 41 to move to the first position. In the slurry balance mode, the bracing shoe mechanism 32 retracts the bracing plate 321 into the opening to close the opening, and the movable mechanism 43 drives the closing division plate 41 to move to the second position.

The dual-mode shield machine provided in the present application has the slurry balance mode and the dual-shield mode, enabling it to be suitable for tunneling construction in complex

underground environments, so that it can be used for both construction in soft and loose soil layers, and construction in soft rock and hard rock and very hard rock strata, thus significantly improving the construction efficiency. In the dual-shield mode, an oil cylinder of the bracing shoe mechanism 32 extends out the bracing plate 321 of the bracing shield 3 and then presses the bracing plate against an excavated rock layer. In this way, the front shield continues to advance through extension and contraction of an oil cylinder of the telescopic shield 2, while the rear shield remains stationary, and pre-fabricated segments are synchronously assembled in an annular manner within the rear shield. In the slurry balance mode, the telescopic shield 2 and the bracing plate 321 of the bracing shield 3 retract into place, the central movable platform 4 moves into place in the direction towards the bracing shield 3, and a slurry chamber is formed by a space between the closing division plate 41 of the central movable platform 4, the inner cavity of the front shield 1, and the cutter head. A dual-shield central rotary joint is removed, then a slurry-mode central rotary joint is installed, and a mud gate in an air cushion chamber is opened to fill it with mud.

In the slurry balance mode, referring to Fig. 3, the telescopic shield 2 and the front shield 1 get closer to each other, and the first sealing member a closes the gap between the inner wall of the front shield cylinder housing 11 and the outer wall of the telescopic cylinder casing 21, so that a sealed cavity is formed inside the shield machine to satisfy operational requirements of the shield machine in the slurry balance mode. The first sealing member a may be a sealing ring and is sleeved on the outer wall of the telescopic cylinder housing 21 of the telescopic shield 2 or on the inner wall of the front shield cylinder housing 11. The shield machine may include a plurality of the first sealing members a. The first sealing members a are spaced sequentially along a length direction of the telescopic shield 2, the first sealing members a are arranged in parallel, and the first sealing members a have the same diameter. In the slurry balance mode, the first sealing members a are compressed between the front shield cylinder housing 11 and the telescopic cylinder housing 21 to seal the gap therebetween.

In this embodiment, referring to Fig. 4, the inner wall of the front shield cylinder housing 11 is provided with a second sealing fit ring 12 that protrudes therefrom. An outer ring of the second sealing fit ring 12 is connected to the inner wall of the front shield cylinder housing 11, and an inner ring side of the second sealing fit ring 12 extends towards an axis of the front

shield cylinder housing 11. An end of the telescopic cylinder housing 21 is provided with a second sealing fit flange 22. One of the second sealing fit ring 12 and the second sealing fit flange 22 is provided with a second sealing member b. In a state where the telescopic cylinder housing 21 has extended into the front shield cylinder housing 11 to a limit position, the second sealing member b closes a gap between the second sealing fit flange 22 and the second sealing fit ring 12. The second sealing member b may be a sealing ring and is provided on a surface of the second sealing fit ring 12 or the second sealing fit flange 22. The shield machine may include a plurality of the second sealing members b. The second sealing members b are spaced sequentially along a radial direction of the second sealing fit ring 12, the second sealing members b have different diameters, and the second sealing members b are disposed concentrically. In the slurry balance mode, the telescopic cylinder housing 21 moves towards an inner side of the front shield cylinder housing 11 until the second sealing fit flange 22 and the second sealing fit ring 12 come into contact, and the second sealing member b is elastically compressed between the second sealing fit ring 12 and the second sealing fit flange 22 to seal the gap therebetween.

In this embodiment, on the basis of the first sealing members a, the second sealing members b are further provided, and the design of the two different sealing structures significantly improves a sealing effect between the front shield cylinder housing 11 and the telescopic cylinder housing 21.

In this embodiment, referring to Fig. 4, the slurry balance and dual-shield dual-mode shield machine includes fasteners g. The fasteners g are configured to pass through both the second sealing fit flange 22 and the second sealing fit ring 12 to fixedly connect the second sealing fit flange 22 and the second sealing fit ring 12 together. In this way, in the slurry balance mode, the state of the shield machine is stable, and the front shield cylinder housing 11 and the telescopic cylinder housing 21 do not move relative to each other.

In a possible embodiment, referring to Figs. 5 and 6, the slurry balance and dual-shield dual-mode shield machine further includes the front shield 1 and the central movable platform 4. The front shield 1 has a third sealing fit housing 13 communicated with the inner cavity thereof. The central movable platform 4 has the closing division plate 41 and the central movable platform sealing housing 42. One of the central movable platform sealing housing 42

and the third sealing fit housing 13 is provided with a third sealing member c. In the slurry balance mode, in a state where the central movable platform 4 has extended into the inner cavity of the front shield 1, the third sealing member c is configured to seal a gap between the central movable platform sealing housing 42 and the third sealing fit housing 13. The third sealing member c may be a sealing ring and is provided in a manner of extending along a circumference of an outer edge of the third sealing fit housing 13 or along a circumference of an outer edge of the central movable platform sealing housing 42, to seal the gap therebetween. One end of a fixing member is passed through the third sealing member c to fixedly connect the third sealing member c to the central movable platform sealing housing 42 or the third sealing fit housing 13. An outer side face of the third sealing member c may be provided with a recessed portion to facilitate accommodating a cap body of the fixing member, and the cap body of the fixing member does not protrude from the outer side face of the third sealing member c. An inner side face of the third sealing member c is in direct contact with a surface of the central movable platform sealing housing 42 or the third sealing fit housing 13. The shield machine may include a plurality of the third sealing members c. The third sealing members c are spaced sequentially along a length direction of the central movable platform sealing housing 42, the third sealing members c are arranged in parallel, and the third sealing members c have the same diameter. One or more lubrication blocks may be provided on two sides of the third sealing member c to reduce surface friction between the central movable platform sealing housing 42 and the third sealing fit housing 13 and to improve a sealing effect of the third sealing member c.

In this embodiment, referring to Figs. 6 and 7, an outer wall of the third sealing fit housing 13 of the front shield 1 is provided with a fourth sealing flange 131, and one of an edge of the closing division plate 41 and the fourth sealing flange 131 is provided with a fourth sealing member d. In the slurry balance mode, the central movable platform 4 moves in the direction towards the bracing shield 3 until an outer side of the closing division plate 41 comes into contact with the fourth sealing flange 131, the fourth sealing member d seals a gap between the closing division plate 41 and the fourth sealing flange 131, and a slurry chamber is formed by a space between the closing division plate 41, the inner cavity of the front shield 1, and the cutter head. The fourth sealing member d may be a sealing ring and is provided in a manner of extending along a circumference of an outer edge of the closing division plate 41 or along a

circumference of an outer edge of the fourth sealing flange 131, to seal the gap therebetween. The shield machine may include a plurality of the fourth sealing members d. The fourth sealing members d are spaced sequentially along a radial direction of the closing division plate 41, the fourth sealing members d have different diameters, and the fourth sealing members d are disposed concentrically.

In this embodiment, on the basis of the third sealing members c, the fourth sealing members d are further provided, and the design of the two different sealing structures significantly improves a sealing effect of the slurry chamber.

In a possible embodiment, referring to Figs. 8 to 10, the slurry balance and dual-shield dual-mode shield machine includes a bracing shield 3. The bracing shield 3 is connected to the telescopic shield 2. The bracing shield 3 includes a bracing cylinder housing 31 and a bracing shoe mechanism 32. The bracing cylinder housing 31 has an opening. The bracing shoe mechanism 32 includes a bracing plate 321. The bracing shoe mechanism 32 can extend the bracing plate 321 out of the opening or retract the bracing plate into the opening. In the slurry balance mode, the bracing shoe mechanism 32 can retract the bracing plate 321 into the opening. At least one of an inner wall of the opening and a circumferential edge of the bracing plate 321 is provided with a fifth sealing member e. In a state where the bracing plate 321 has retracted into the opening, the fifth sealing member e seals a gap between the bracing plate 321 and the bracing cylinder housing 31.

In this embodiment, the fifth sealing member e may be a sealing ring and is fixed to the inner wall of the opening of the bracing cylinder housing 31 or the circumferential edge of the bracing plate 321. The shield machine may include a plurality of the fifth sealing members e. The fifth sealing members e are disposed sequentially along a movement direction of the bracing plate 321. In the slurry balance mode, the bracing shoe mechanism 32 retracts, causing the bracing plate 321 to retract into the opening. The fifth sealing members e are compressed between the edge of the bracing plate 321 and the inner wall of the opening of the bracing cylinder housing 31 to seal the gap therebetween.

In this embodiment, the fifth sealing members e are provided in a manner of extending along a circumference of the inner wall of the opening or along a circumference of the circumferential edge of the bracing plate 321, and one end of a fixing member is passed through

the fifth sealing members e and connected to the inner wall of the opening of the bracing cylinder housing 31 or the circumferential edge of the bracing plate 321. In a state where the bracing plate 321 has retracted into the opening, the fifth sealing members e are compressed between the bracing plate 321 and the inner wall of the opening.

In this embodiment, the fifth sealing members e may be fixed to the inner wall of the opening of the bracing cylinder housing 31 or the circumferential edge of the bracing plate 321 by means of fixing members. One end of each of the plurality of fixing members is passed through the fifth sealing member e and connected to the inner wall of the opening of the bracing cylinder housing 31 or the circumferential edge of the bracing plate 321. A cap body at the other end of the fixing member is confined to the fifth sealing member e. An outer side face of the fifth sealing member e may be provided with a recessed portion to facilitate accommodating the cap body of the fixing member, and the cap body of the fixing member does not protrude from the outer side face of the fifth sealing member e. An inner side face of the fifth sealing member e is in direct contact with a surface of the bracing plate 321 or the bracing cylinder housing 31. The shield machine may include a plurality of the fifth sealing members e. The fifth sealing members e are spaced sequentially along a length direction of the inner wall of the opening of the bracing cylinder housing 31, the fifth sealing members e are arranged in parallel, and the fifth sealing members e have the same diameter. One or more lubrication blocks may be provided on two sides of the fifth sealing member e to reduce surface friction between the inner wall of the opening of the bracing cylinder housing 31 or the circumferential edge of the bracing plate 321 and to improve a sealing effect of the fifth sealing member e.

In this embodiment, referring to Fig. 10, a sixth sealing fit ring 311 is provided on an inner side of the bracing cylinder housing 31. An inner ring edge of the sixth sealing fit ring 311 extends towards a central axis of the opening. In a state where the bracing plate 321 has retracted into the opening, the bracing plate 321 and the sixth sealing fit ring 311 are in sealing fit with each other.

In this embodiment, the bracing plate 321 is provided with the annular sixth sealing member f on a side facing an inner side of the bracing cylinder housing 31. In a state where the bracing plate 321 has retracted into the opening, the sixth sealing member f seals a gap between the bracing plate 321 and the sixth sealing fit ring 311.

In this embodiment, the sixth sealing member f may be a sealing ring and is provided on the edge of the bracing plate 321. The shield machine may include a plurality of the sixth sealing members f. The sixth sealing members f are spaced sequentially along a radial direction of the sixth sealing fit ring 311, the sixth sealing members f have different diameters, and the sixth sealing members f are disposed concentrically. In the slurry balance mode, the bracing plate 321 retracts into the opening, and the sixth sealing members f are compressed between the sixth sealing fit ring 311 and the bracing plate 321 to seal the gap therebetween.

In this embodiment, referring to Fig. 11, the slurry balance and dual-shield dual-mode shield machine shield further includes an air bag member h. The air bag member h is provided on a surface of the bracing cylinder housing 31 and the air bag member h is arranged around a whole circumference of an edge of the opening, or the air bag member h is provided on the bracing plate 321 and the air bag member h is arranged around a whole circumference of an edge of the bracing plate 321. In a state where the bracing plate 321 has retracted into the opening, the air bag member h covers a gap between the bracing plate 321 and the bracing cylinder housing 31, thus further improving a sealing effect between the bracing cylinder housing 31 and the bracing plate 321.

In this embodiment, on the basis of the fifth sealing member e, the sixth sealing member f and the air bag member h are further provided, and the design of the three different sealing structures significantly improves the sealing effect between the bracing cylinder housing 31 and the bracing plate 321.

The slurry balance and dual-shield dual-mode shield machine provided in embodiments of the present application may start tunneling in either mode and convert to a second mode before entering a different type of stratum. Taking the conversion from the dual-shield mode to the slurry balance mode as an example, before a designated conversion position is reached, tunneling is continued and the telescopic shield 2 is slowly retracted into place; after the telescopic shield 2 has retracted into place, the telescopic shield 2 is connected and fastened by means of fasteners g (e.g., bolts), and sealing and articulated sealing statuses of the telescopic shield 2 are checked; the bracing shoe mechanism 32 retracts the bracing plate 321 on both sides into place, and ensures that sealing at the position of the bracing plate 321 is in a compressed state, and a left and a right mechanical limit of the bracing shoe mechanism 32 is

provided to prevent the bracing plate 321 from extending out unexpectedly; a dual-shield central rotary joint is removed, and a belt conveyor or other muck discharge equipment is removed; after the central movable platform 4 is moved integrally into place in the direction towards the bracing shield 3 by using an oil cylinder, a muck chute and a scraping plate at the back of the cutter head are removed to form a slurry chamber, and a slurry-mode central rotary joint is installed; a mud gate in an air cushion chamber is opened, a mud hose at the position of the based on central movable platform 4 is connected, the statuses at the positions of the air cushion chamber, ball valves of the housings, and interfaces are checked to ensure that sealing meets requirements, and the statuses of a slurry circulation system and related components are checked to ensure that their functions meet requirements; other safety matters are checked, and after conditions are met, the slurry circulation system is started progressively to enter the slurry balance mode for tunneling. Taking the conversion from the slurry balance mode to the dual-shield mode as an example, after a designated conversion position is reached, tunneling is stopped, the slurry circulation system is turned off, the mud hose at the position of the central movable platform 4 is disconnected, and the mud gate in the air cushion chamber is closed; the slurry-mode central rotary joint is removed, the muck chute and the scraping plate at the back of the cutter head are installed, and after the central movable platform 4 is moved integrally into place in the direction towards the cutter head by using the oil cylinder, a muck chamber is formed, and the dual-shield central rotary joint, and the belt conveyor or other muck discharge equipment are installed; the mechanical limits of the bracing shoe mechanism 32 on both sides are released, and the bracing shoe mechanism 32 extends the bracing plate 321 on both sides out of the bracing cylinder housing 31 and tightly presses the bracing plate against an excavated rock layer; the fasteners g between the front shield 1 and the telescopic shield 2 are removed, and the oil cylinder and the cutter head of the front shield 1 are started to enter the dual-shield mode for tunneling.

It should be noted that, in view of a complex structure of a shield machine, the present application mainly describes structures of improved parts of the shield machine, and parts not described in detail in the present application may be conventional or existing structures of a shield machine.

The above description only involves preferred embodiments of the present application,

and does not limit the present application in any form. Although the present application has been disclosed above with the preferred embodiments, the present application is not limited thereto. Any persons skilled in the art can use the suggested technical contents described above to make some alterations or modifications to produce equivalent embodiments with equivalent variations without departing from the scope of the technical solutions of the present application. All simple amendments, equivalent variations, and modifications made to the above embodiments according to the technical essence of the present application without departing from the technical solutions of the present application still fall within the scope of the solutions of the present application.

Claims

1. A slurry balance and dual-shield dual-mode shield machine, comprising:

a front shield, having a front shield cylinder housing;

a telescopic shield, having a telescopic cylinder housing, wherein the front shield cylinder housing is slidably sleeved on the telescopic cylinder housing, and one of an inner wall of the front shield cylinder housing and an outer wall of the telescopic cylinder housing is provided with a first sealing member, which is configured to tightly seal a gap between the inner wall of the front shield cylinder housing and the outer wall of the telescopic cylinder housing;

a bracing shield, connected to the telescopic shield, the bracing shield having a bracing cylinder housing and a bracing shoe mechanism, wherein the bracing cylinder housing has an opening, and the bracing shoe mechanism comprises a bracing plate, and the bracing shoe mechanism is configured to extend the bracing plate out of the opening or retract the bracing plate into the opening; and

a central movable platform located on an inner side of both the front shield and the telescopic shield, the central movable platform comprising a central movable platform sealing housing and a closing division plate, wherein the central movable platform sealing housing is connected to the front shield by a movable mechanism; the closing division plate is provided at an end of the central movable platform sealing housing; and the movable mechanism is configured to perform telescopic movement to cause the closing division plate to move to a first position which is close to a cutter head or a second position which is close to the telescopic shield, wherein in a state where the closing division plate has moved integrally to the first position in the direction towards the cutter head, a non-closed muck chamber is formed between an inner cavity of the front shield and the cutter head provided on the front shield; and in a state where the closing division plate has moved integrally to the second position in the direction towards the bracing shield, a slurry chamber closed in a slurry balance mode is formed between the closing division plate, the inner cavity of the front shield and the cutter head provided on the front shield, wherein

the slurry balance and dual-shield dual-mode shield machine has a dual-shield mode and the slurry balance mode, wherein in the dual-shield mode, the bracing shoe mechanism extends out the bracing plate so that the bracing plate is supported on rock, and the movable mechanism

drives the closing division plate to move to the first position, and in the slurry balance mode, the bracing shoe mechanism retracts the bracing plate into the opening to close the opening, and the movable mechanism drives the closing division plate to move to the second position.

2. The slurry balance and dual-shield dual-mode shield machine according to claim 1, wherein the inner wall of the front shield cylinder housing is provided with a second sealing fit ring that protrudes therefrom;

an end of the telescopic cylinder housing is provided with a second sealing fit flange;

one of the second sealing fit ring and the second sealing fit flange is provided with a second sealing member; and

in the slurry balance mode, the telescopic shield retracts into place, and in a state where the telescopic cylinder housing has extended into the front shield cylinder housing to a limit position, the second sealing member is configured to tightly seal a gap between the second sealing fit flange and the second sealing fit ring.

3. The slurry balance and dual-shield dual-mode shield machine according to claim 2, comprising fasteners, wherein

in the slurry balance mode, the telescopic shield retracts into place, and the fasteners are configured to pass through both the second sealing fit flange and the second sealing fit ring to fixedly connect the second sealing fit flange and the second sealing fit ring together.

4. The slurry balance and dual-shield dual-mode shield machine according to claim 3, wherein the front shield has a third sealing fit housing communicated with the inner cavity thereof;

one of the central movable platform sealing housing and the third sealing fit housing is provided with a third sealing member;

the third sealing member is provided in a manner of extending along a circumference of an inner wall of the third sealing fit housing or along a circumference of an outer wall of the central movable platform sealing housing;

the third sealing member is fixedly connected to the central movable platform sealing housing or the third sealing fit housing by means of fixing members, one end of each fixing member being passed through the third sealing member; and

the third sealing member is configured to seal a gap between the central movable platform

sealing housing and the third sealing fit housing.

5. The slurry balance and dual-shield dual-mode shield machine according to claim 4, wherein an outer wall of the third sealing fit housing of the front shield is provided with a fourth sealing flange;

one of an edge of the closing division plate and the fourth sealing flange is provided with a fourth sealing member; and

in the slurry balance mode, in a state where the central movable platform has moved to a limit position in the direction towards the bracing shield, the fourth sealing member seals a gap between the closing division plate and the fourth sealing flange, and the slurry chamber is formed by a space between the closing division plate, the inner cavity of the front shield, and the cutter head.

6. The slurry balance and dual-shield dual-mode shield machine according to claim 5, wherein at least one of an inner wall of the opening of the bracing cylinder housing and a circumferential edge of the bracing plate is provided with a fifth sealing member; and

in the slurry balance mode, in a state where the bracing plate has retracted into the opening, the fifth sealing member seals a gap between the bracing plate and the bracing cylinder housing.

7. The slurry balance and dual-shield dual-mode shield machine according to claim 6, wherein the fifth sealing member is provided in a manner of extending along a circumference of the inner wall of the opening or along a circumference of the circumferential edge of the bracing plate;

the fifth sealing member is fixedly connected to the inner wall of the opening of the bracing cylinder housing or the circumferential edge of the bracing plate by means of fixing members, one end of each fixing member being passed through the fifth sealing member; and

in a state where the bracing plate has retracted into the opening, the fifth sealing member is compressed between the bracing plate and the inner wall of the opening.

8. The slurry balance and dual-shield dual-mode shield machine according to claim 7, wherein a sixth sealing fit ring is provided on an inner side of the bracing cylinder housing;

an inner edge of the sixth sealing fit ring extends towards a central axis of the opening; and

in the slurry balance mode, the bracing plate retracts into the opening, and the bracing

plate and the sixth sealing fit ring are in sealing fit with each other.

9. The slurry balance and dual-shield dual-mode shield machine according to claim 8, wherein the bracing plate is provided with an annular sixth sealing member on a side facing an inner side of the bracing cylinder housing; and

in the slurry balance mode, the bracing plate retracts into the opening, and the sixth sealing member tightly seals a gap between the bracing plate and the sixth sealing fit ring.

10. The slurry balance and dual-shield dual-mode shield machine according to claim 9, further comprising an air bag member, wherein

the air bag member is provided on a surface of the bracing cylinder housing and the air bag member is arranged around a whole circumference of an edge of the opening, or the air bag member is provided on the bracing plate and the air bag member is arranged around a whole circumference of an edge of the bracing plate; and

in the slurry balance mode, the bracing plate retracts into the opening, and the air bag member covers and tightly seals a gap between the bracing plate and the bracing cylinder housing.