

A shield-type tunneling machine

This invention relates to a shield-type tunneling machine, according to the prior art part of Claim 1. A tunneling machine of this kind is shown (US—A—3 917 351) and may be used in performing the so-called earth-pressure-resisting type shield tunneling method. With this method a liquid such as sludge is caused to act on the facing ground under a pressure substantially equal to an underground water pressure in the facing, and a degree of opening of respective cutter slit is controlled, so that a cutter head can be pressed on the facing ground under a pressure larger than an active earth pressure of the facing ground but smaller than a passive earth pressure thereof, preventing the collapse of the facing.

In order to carry out such a method, the shield-type tunneling machine is equipped with a mechanism for adjusting a degree of opening of slits in a cutter disc. The conventional slit-opening adjusting mechanism has been such that the bit-plates are individually set to a desired angle with respect to the ground by hydraulic rams actuating the bit-plates towards or away from the facing, so that, according to a degree of movement of the bit-plates relative to the facing, the opening of respective slits and the cutting angle may be adjusted.

Such a mechanism, however, has the drawbacks of requiring a complex and delicate control and drive means for actuating the bit-plates.

The invention as claimed is intended to provide a shield-type tunneling machine equipped with improved slit-opening adjusting mechanisms for adjusting a cutting angle of cutter bits with respect to the facing to an optimum degree.

According to the present invention a slide shaft is disposed within said hollow rotary shaft for rotation therewith, and in that said means for pivotally moving said slit-opening members comprise first and second trunnions having arms pivoted to the opposite sides of the front end of said slide shaft, said trunnions extending at one end thereof into said first slit and at the other ends into said second slit, said means further comprising an interlocking mechanism interconnecting said first and second trunnions with each other and rotating said trunnions mutually in opposite directions when said slide shaft is caused to reciprocate; one end of said first trunnion being secured to one of the bit-plates of said first slit-opening member, and one end of said second trunnion being pivoted to the other bit-plate of said first slit-opening member; the other end of said first trunnion being pivoted to one of the bit-plates of said second slit-opening member, and the other end of said second trunnion being secured to the other bit-plate of said second slit-opening member, to thereby open or close said respective cutter

slits, when said slide shaft is slidingly moved in the axial direction thereof.

The advantages offered by the present invention are mainly that the cutting angle can be selected freely but by reliable means and that simplicity in the manufacturing process is achieved.

One way of carrying out the invention is described in detail below with reference to drawing which illustrate a preferred embodiment, in which:

Fig. 1 is a longitudinal cross sectional view of a shield-type tunneling machine according to the present invention, Fig. 2 is a fragmentary cross sectional view of a cutter disc, Fig. 3 is an elevational view of the cutter disc, Fig. 4 is a plan view of a comb-type bit-plate, Fig. 5 is a cross-sectional view taken along the line 5—5 of Fig. 3, and Figs. 6(a), (b), 7(a), (b) and 8(a), (b) illustrate the relationship between the sliding movement of a slide shaft and the pivotal movement of the bit-plates to an open close positions, respectively.

Referring first to Fig. 1, a shield-type tunneling machine 10 comprises a partition wall or diaphragm 14 fitted in the front position of a shield body 12 across the body. The partition wall 14 carries substantially at center thereof a hollow rotary shaft 16 rotatably, through the medium of two bearings 14a and 14b. A duct 15a for introducing pressurized fluid to the front of the shield body and a duct 15b for discharging muck are attached to the partition wall 14.

A cutter disc 18 positioned at the front of the partition wall 14 is attached to the front end of the rotary shaft 16. The rotary shaft 16 has a drive gear 20 mounted thereon at the rear of the partition wall 14. The drive gear 20 is in mesh with a pinion gear 26 coupled through the medium of a reduction gear 24 to a hydraulic motor 22, so that the drive gear 20 will be driven when the hydraulic motor 22 is run. The hydraulic motor 22 which is a drive source may be replaced by an electric motor (not shown).

A slide shaft 28 is disposed in the hollow rotary shaft 16 and extends through the entire length thereof, with one end thereof projecting into a recess 17 in a diametrically enlarged portion 16a of the rotary shaft 16, and with the other end projecting outward of the rear end 16b thereof. There is provided a mechanism for rotating the slide shaft 28 integrally with the rotary shaft 16 as well as for causing the slide shaft to reciprocate axially thereof. The slide-shaft-reciprocating mechanism includes plural pairs of hydraulic cylinders 30 and 32.

One pair of hydraulic cylinders 30 are attached to the partition wall 14, and the other pair of hydraulic cylinders 32 are coupled through the medium of the bearing 33a and brackets 33b to the slide shaft 28, which

(15)

bearing allows rotation of the slide shaft. A piston rod 34 is fitted in each of the pair of hydraulic cylinders 30, extends therefrom, is slidably supported by a bracket 36 attached through the medium of a bearing 35 to the rotary shaft 16, and eventually fitted into each of the other pair of hydraulic cylinders 32. In respective hydraulic cylinder 30, there are defined two oil chambers 30a and 30b, in which are lodged two pistons 38 and 40 rigidly secured to the piston rod 34. In respective hydraulic cylinders 32, there is provided a piston 42 attached to the end of the piston rod 34.

A rectangular block 43 is attached to the front end of the slide shaft 28. Arms 48 and 50 of a pair of trunnions 44 disposed in the diametrically enlarged portion 16a of the rotary shaft 16 are pivotally supported by pins 52 (Fig. 2) on the opposite sides of a block 53 attached to the front end of the slide shaft.

The cutter disc 18 attached to the front end of the rotary shaft 16 in the diametrically enlarged portion 16a thereof presents a circular cross section, as seen in Fig. 3. A surface plate 56 is provided with a first cutter slit 58 and a second cutter slit 50 which are diametrically aligned with each other. One ends 44a and 46a of the first and second trunnions 44 and 46 extend into the first cutter slit 58, and the other ends 44b and 46b thereof extend into the second cutter slit 60.

A slit-opening member consisting of a pair of comb-type bit-plates is disposed in each of the cutter slits. More in detail, a pair of elongated bit-plates 64 and 66, each having a plurality of equally spaced bits 62 attached thereto and presenting a comb-shape as shown in Fig. 4, are disposed in the first cutter slit 58 in a manner that a series of bits of one bit-plate 64 are in mesh with a series of bits of the other bit-plate 66. In Fig. 3, the cutter slit 58 is shown as being completely closed. Likewise, a second slit-opening member consisting of a pair of bit-plates 68 and 70 is disposed within the second cutter slit 60.

Respective bit-plates are pivotally supported on the surface plate 56 in a manner to effect an angular rotation, in order to adjust a degree of opening of respective cutter slits and select a proper cutting angle. More in detail, respective bit-plates are coupled by pins to brackets 72, 74, 76 and 78, respectively, one ends of which are attached to the surface plate 56, and the other ends of which are fitted in cuts 71 provided in respective bit-plates.

Turning back to Fig. 2, one end 44a of the trunnion 44 presents a rectangular cross section and is coupled to the bit-plate 64 of the first slit-opening member so as to rotate integrally therewith. One end 46a of the trunnion 46 presents a circular cross section and pivotally movably supports the bit-plate 66 of the first slit-opening member.

The other end 44b of the trunnion 44 presents a circular cross section and pivotally

movably supports the bit-plate 68 of the second slit-opening member. The other end 46b of the trunnion 46 presents a rectangular cross section and is coupled to the bit-plate 70 of the second slit-opening member so as to rotate integrally therewith.

As seen in Fig. 5, an interlocking mechanism is provided across the pair of bit-plates 64 and 66, the interlocking mechanism interconnecting the pair of bit-plates with each other and causing these bit-plates to pivotally move mutually in opposite directions, so that when one bit-plate is turned to the exterior of the cutter slit, namely, outward of the surface plate 56 which is on the facing side, then the other bit-plate is turned inward of the slit, namely, inward of the surface plate. The interlocking mechanism comprises an arm member 80 attached at one end to the bit-plate 64; an arm member 82 attached at one end to the bit-plate 66, both arm members extending upright from the axes of the trunnions 44 and 46, when the bit-plates 64 and 66 assume a fully closed position; and a rod 88 pivotally secured by pins 84 and 86 to the other ends of both arm members. Another interlocking mechanism is provided for the bit-plates 68 and 70 which constitute the second slit-opening member.

By the cooperation of the pair of trunnions 44 and 46 for transmitting a rotational force to one bit-plates 64 and 70 alone of the pairs of bit-plates with the interlocking mechanism for pivotally moving respective pairs of bit-plates 64, 66 or 68, 70 in opposite directions, the operations of the bit-plates as shown in Figs. 6, 7 and 8 accomplished.

Referring to Figs. 7(a) and 7(b), showing the bit-plates in the fully close condition, which correspond to Figs. 3 and 5, the slide shaft 28 assumes a home position, and the cutter slit 58 is maintained in a fully close condition by the bit-plates 64 and 66.

Where it is desired to cut the natural ground by rotating the cutter disc 18 clockwise, as viewed from the facing side, the slide shaft 28 is slidably moved from the position shown in Fig. 7(a) downward as viewed in Fig. 7(a) to the left in Fig. 1). The length of sliding movement of the slide shaft 28 is determined by a cutting angle of the bits which is selected according to the nature of the soil of the facing ground. As the trunnion 44 is rotated by the sliding movement of the slide shaft 28, the bit-plate 64 is pivotally moved outward, and the bit-plate 66 is pivotally moved in a direction opposite thereto, namely, inward of the slit.

Where it is desired to cut the natural ground by rotating the cutter disc 18 counterclockwise as viewed from the facing side, the slide shaft 28 is slidably moved from its home position [Fig. 7(a)] in an opposite direction to that of the former case, namely, upward in Fig. 8(a) (to the right in Fig. 1). As the trunnion 44 is rotated by the sliding motion of the slide shaft 28, the bit-plate 64 is pivotally moved in the same

direction as the direction of shift of the slide shaft 28, namely, inward, and the other bit-plate 66 is pivotally moved by means of the interlocking mechanism in an opposite direction to the direction of movement of the bit-plate 28, namely, outward of the slit or toward the facing. A predetermined cutting angle is thus obtained, and the bits 62 are used for cutting the soil at the cutting angle thus obtained.

In the foregoing, description has been given to the operation of one pair of bit-plates 64 and 66 constituting the first slit-opening member, which is caused by the sliding movement of the slide shaft 28. The other pair of bit-plates plates 68 and 70 constituting the second slit-opening member operate in like manner as described above, with the exception that the bit-plate 70 is pivotally moved with rotation of the trunnion 46, and the bit-plate 68 is pivotally moved in association with the pivotal movement to the open position or the close position, of the bit-plate 70. Therefore, when the cutter disc 18 is rotated clockwise, the bit-plate 64 is pivotally moved outward of the slit and at the same time, the bit-plate 70 positioned catercorner to the bit-plate 64 (Fig. 3) is pivotally moved outward of the slit. When the cutter disc 18 is rotated counterclockwise, the bit-plate 66 is turned outward of the slit as well as the bit-plate 68 positioned catercorner to the bit-plate 66 is pivotally moved outward thereof in like manner.

As can be seen from the foregoing, respective slit-opening member is composed of a pair of comb-type bit-plates, and a cutting angle of the comb-type bit-plate with respect to the facing is freely adjusted by selecting the length of sliding movement of the slide shaft, irrespective of a direction of rotation of the cutter disc, so that the shield-type tunneling machine can find a wide application to either a soft soil or a hard soil, as well as the tunneling work is facilitated.

If one bit-plate of the pair of bit-plates is pivotally moved towards the facing side, then the other bit-plate is pivotally moved in a direction opposite thereto, such that resistance between the natural ground and the bits is greatly reduced, and the pivotal movement to the open and close positions, of the pair of bit-plates eliminates a risk of gravels or the like jamming in the slits.

Since a pair of bit-plates are provided in each cutter slit, and a direction of rotation of the cutter disc is properly reversed, the bits no longer suffer from local wear, with the result of the extended service life of the bits.

Furthermore, since the cutter slits are opened or closed by the pivotal movement, rather than the sliding motion, of the bit-plates, the improved sealing is provided between the bit-plates and the slits, as well as the simplicity in manufacture is provided. The cutter disc and the associated members may be availed for a

shield-type tunneling machine of a large diameter.

When the cutter disc is stopped, the bit-plates always assume the fully close positions, such that the collapse of the ground is prevented, coupled with the improved sealing property. The present invention may be thus applied to an earth-pressure-resisting type shield tunneling machine.

Claims

1. A shield-type tunneling machine comprising a partition wall (14) provided across a shield body (12), a hollow rotary shaft (16) rotatably supported within said shield body, a cutter disc (18) attached to the front end of said rotary shaft at the front of said partition wall and including first and second cutter slits (58, 60) provided therein a diametrical alignment with each other, a first slit-opening member comprising a pair of comb-type bit-plates (64, 66) disposed in said first cutter slit (58) and a second slit-opening member comprising a pair of comb-type bit-plates (68, 70) disposed in said second cutter slit (60), and means (44, 46, 48, 50, 80, 82, 84, 86, 88) for pivotally moving said slit-opening members to thereby open or close said respective cutter slits, characterized in that a slide shaft (28) is disposed within said hollow rotary shaft (16) for rotation therewith, and in that said means for pivotally moving said slit-opening members comprises first and second trunnions (44, 46) having arms (48, 50) pivoted to the opposite sides of the front end of said slide shaft (28), said trunnions extending at one ends thereof into said first slit (58) and at the other ends into said second slit (60), said means further comprising an interlocking mechanism (80, 82, 84, 86, 88) interconnecting said first and second trunnions with each other and rotating said trunnions mutually in opposite directions when said slide shaft is caused to reciprocate; one end (44a) of said first trunnion (44) being secured to one of the bit-plates (64, 66) of said first slit-opening member, and one end (46a) of said second trunnion (46) being pivoted to the other bit-plate of said first slit-opening member; the other end (44b) of said first trunnion (44) being pivoted to one of the bit-plates (68, 70) of said second slit-opening member, and the other end (46b) of said second trunnion (46) being secured to the other bit-plate of said second slit-opening member, to thereby open or close said respective cutter slits, when said slide shaft is slidingly moved in the axial direction thereof.

2. A shield-type tunneling machine as claimed in claim 1, in which said respective slit-opening members are formed by arranging said pair of comb-type bit-plates (64, 66) (68, 70) in a manner that the bits (62) of one bit-plate are in mesh with the bits of the other bit-plate.

direction as the direction of shift of the slide shaft 28, namely, inward, and the other bit-plate 66 is pivotally moved by means of the interlocking mechanism in an opposite direction to the direction of movement of the bit-plate 28, namely, outward of the slit or toward the facing. A predetermined cutting angle is thus obtained, and the bits 62 are used for cutting the soil at the cutting angle thus obtained.

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If one bit-plate of the pair of bit-plates is pivotally moved towards the facing side, then the other bit-plate is pivotally moved in a direction opposite thereto, such that resistance between the natural ground and the bits is greatly reduced, and the pivotal movement to the open and close positions, of the pair of bit-plates eliminates a risk of gravels or the like jamming in the slits.

Since a pair of bit-plates are provided in each cutter slit, and a direction of rotation of the cutter disc is properly reversed, the bits no longer suffer from local wear, with the result of the extended service life of the bits.

Furthermore, since the cutter slits are opened or closed by the pivotal movement, rather than the sliding motion, of the bit-plates, the improved sealing is provided between the bit-plates and the slits, as well as the simplicity in manufacture is provided. The cutter disc and the associated members may be availed for a

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2. A shield-type tunneling machine as claimed in claim 1, in which said respective slit-opening members are formed by arranging said pair of comb-type bit-plates (64, 66) (68, 70) in a manner that the bits (62) of one bit-plate are in mesh with the bits of the other bit-plate.



Patentansprüche

1. Schildvortriebs-Tunnelbaumaschine mit einer Trennwand (14), die sich quer durch einen Schildkörper (12) erstreckt, einer drehbaren Hohlwelle (16), die vom Schildkörper drehbar getragen wird, einer Schneid- oder Bohrscheibe (18), die vor der Trennwand am vorderen Ende der Hohlwelle angebracht ist sowie erste und zweite Bohrspalte (58, 60) aufweist, die in der Bohrscheibe diametral zueinander verlaufend ausgebildet sind, einem ersten Spaltöffnungselement, das zwei im ersten Bohrspalt (58) angeordnete, kammartige Meißelplatten (64, 66) aufweist, und ein zweites Spaltöffnungselement, das zwei im zweiten Bohrspalt (60) angeordnete, kammartige Meißelplatten (68, 70) aufweist, sowie Mitteln (44, 46, 48, 50, 80, 82, 84, 86, 88) zum Verschwenken der Spaltöffnungselemente, um dadurch die jeweiligen Bohrspalte zu öffnen oder zu schließen, dadurch gekennzeichnet, daß eine Gleitwelle (28) innerhalb der drehbaren Hohlwelle (16) angeordnet und zusammen mit dieser drehbar ist und daß die Mittel zum Verschwenken der Spaltöffnungselemente einen ersten und einen zweiten Drehzapfen (44, 46), die Arme (48, 50) aufweisen, die an entgegengesetzten Seiten des vorderen Endes der Gleitwelle (28) drehbar angelenkt sind, wobei die Drehzapfen an ihren eigenen Enden in den ersten Bohrspalt (58) und an ihren anderen Enden in den zweiten Bohrspalt (60) vorstehen, und ferner einen Kopplungsmechanismus (80, 82, 84, 86, 88) umfassen, der den ersten und den zweiten Drehzapfen miteinander verbindet und die Drehzapfen in zueinander entgegengesetzten Richtungen dreht, wenn die Gleitwelle hin- oder herbewegt wird, wobei ein Ende (44a) des ersten Drehzapfens (44) an einer der Meißelplatten (64, 66) des ersten Spaltöffnungselementes befestigt ist und wobei ein Ende (46a) des zweiten Drehzapfens (46) drehbar an der anderen Meißelplatte des ersten Spaltöffnungselementes angelenkt ist, wobei das andere Ende (44b) des ersten Drehzapfens (44) drehbar an einer der Meißelplatten (68, 70) des zweiten Spaltöffnungselementes angelenkt ist und wobei das andere Ende (46b) des zweiten Drehzapfens (46) an der anderen Meißelplatte des zweiten Spaltöffnungselementes befestigt ist, um dadurch die jeweiligen Bohrspalte zu öffnen oder zu schließen, wenn die Gleitwelle in ihrer Axialrichtung gleitend verschoben wird.

2. Schildvortriebs-Tunnelbaumaschine nach Anspruch 1, dadurch gekennzeichnet, daß die jeweiligen Spaltöffnungselemente dadurch gebildet sind, daß die zwei kammartigen Meißelplatten (64, 66; 68, 70) derart angeordnet sind, daß die Meißel (62) einer Meißelplatte mit den Meißeln der anderen Meißelplatte kämmen.

Revendications

1. Machine de creusement de tunnels du type à bouclier, comprenant une cloison séparatrice (14) prévue en travers d'un corps de bouclier (12), un arbre tournant creux (16) monté à rotation dans ce corps, un disque de taille (18) fixé à l'extrémité avant dudit arbre, en avant de la cloison précitée, ce disque comportant une première et une seconde fenêtre de coupe (58, 60) prévues sur lui en étant diamétralement alignées l'une avec l'autre, un premier organe d'ouverture de ces fenêtres comprenant deux plaques porte-lames (64, 66) du type en peigne disposées dans la première (58) desdites fenêtres et un second organe d'ouverture de ces fenêtres comprenant également deux plaques porte-lames (68—70) du type en peigne disposées dans la seconde (60), ainsi que des moyens pour déplacer ces organes par pivotement afin d'ouvrir ou de fermer les fenêtres respectives précitées, caractérisé en ce qu'un arbre coulissant (28) est disposé à l'intérieur dudit arbre creux (16) de façon à tourner avec lui, et en ce que les moyens pour déplacer par pivotement lesdits organes d'ouverture de fenêtres comprennent un premier et un second tourillon (44, 46) qui comportent des bras (48, 50) articulés aux côtés opposés de l'extrémité avant dudit arbre coulissant (28), lesquels tourillons s'étendent par une de leurs extrémités dans la première fenêtre (58) et par l'autre dans la seconde (60), lesdits moyens comprenant en outre un mécanisme d'interconnexion (80, 82, 84, 86, 88) qui relie l'un à l'autre ce premier et ce second tourillon et qui les fait tourner mutuellement en sens inverse lorsqu'on fait aller et venir ledit arbre; une extrémité (44a) du premier tourillon (44) étant fixée à l'une des plaques porte-lames (64, 66) du premier organe d'ouverture de fenêtre et une extrémité du second tourillon (46) étant articulée à l'autre plaque porte-lame de ce premier organe d'ouverture de fenêtre; l'autre extrémité (44b) dudit premier tourillon (44) étant articulée à l'une des plaques porte-lames (68, 70) du second organe d'ouverture de fenêtre, et l'autre extrémité (46b) dudit second tourillon (46) étant fixée à l'autre plaque porte-lames dudit second organe d'ouverture de fenêtre, le tout de façon à ouvrir et à fermer lesdites fenêtres de coupe respectives quand ledit arbre coulissant se déplace suivant son axe.

2. Machine de creusement de tunnels du type à bouclier comme revendiqué en revendication 1, dans laquelle les organes respectifs d'ouverture de fenêtre sont constitués en disposant les paires de plaques porte-lames du type en peigne (64, 66) (68, 70) de façon telle que les lames (62) de l'une se trouvent en engrenement avec celles de l'autre.

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