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Description

This invention relates to a shield type tunneling machine in accordance with the preamble of claim 1. Such shield type tunneling machines are adapted to be used in a pipe jacking method for thrusting a pipe into the ground.

A shield type tunneling machine of the initially described type is known from EP—A—0 122 540. In this shield type tunneling machine the debris excavated from the face by the rotary head is transmitted to a place behind the rotary head and presses against the front of the diaphragm. Thereby a large frictional force between the rotating rotary head and the diaphragm is created.

In a pipe jacking method, as disclosed in US—A—4,311,411, another shield type tunneling machine is disposed in the foremost portion of a plurality of pipes to be thrust. While a tunnel face is excavated by the operation of a rotary cutter head provided in the tunneling machine, a thrust is given to said pipe and the fore tunneling machine by a thrusting jack provided in a shaft and adjacent to the rearmost pipe. Therefore, both the pipe and the tunneling machine are thrust into the ground excavated by the operation of said cutter head.

The rotary cutter head is disposed spaced from and ahead of a diaphragm crossing the interior of a shield body, and debris excavated from a face during thrusting of said tunneling machine and pipe also enters and fills a front area between said cutter head and said diaphragm through said cutter head. The debris filling said front area of the diaphragm serves to transmit the earth pressure on the face to the diaphragm of the shield body and the reaction of the diaphragm to the face is such that the face is stably maintained without collapse or upheaval, by a balance between the reaction and the earth pressure.

Conventionally, the debris is rotated with said cutter head in the front area of said diaphragm and directed toward a discharging means such as a screw conveyor provided on a lower portion of said diaphragm and discharged through the discharging means to the rear of the diaphragm. However, a large frictional force exists between the rotating debris and said diaphragm so that large torque is needed for the rotation of said cutter head. Thus, the provision of a compact drive unit for the cutter head and a compact shield type tunneling machine for a pipe jacking method is hindered, i.e. the provision of a small diameter shield body is difficult.

Since the reduction of frictional force between the debris and the diaphragm has to be considered particularly during the excavation of and thrusting into gravel ground, an embodiment of an effective method of reducing the friction was conventionally executed in which pressurized high concentration muddy water is applied to the face to stabilize the face and give fluidity to the debris. However, the use of the pressurized muddy water needs the subsequent treatment of muddy water mixed with debris, and further the

treatment presents problems concerning installation, cost and the like. In addition, said frictional force is increased in proportion to the pressure exerted to the debris filling the front area of said diaphragm. Therefore, the pressure needs to be reduced as much as possible for reducing the frictional force. However, since the pressure acting on the debris cannot be reduced to a value lower than the active earth pressure of the face ground in order to stabilize the face, the reduction of said frictional force by the lubricating action of the muddy water is naturally limited.

An object of the present invention is to reduce the frictional force produced by debris or mined material rotating together with the cutter head in the front area between the cutter head and the diaphragm and acting between said diaphragm and said debris.

A further object of the present invention is to provide a shield type tunneling machine which can be used for the ground covering a wide range from the soft ground to the hard ground.

A shield type tunneling machine of the initially described type according to the present invention is characterized by the features of the characterizing portion of claim 1.

During operation of the shield type tunneling machine, debris received between the rotary head and the whole inner peripheral surface of the shield body is condensed and moved linearly to be introduced into a discharge port. As a result, friction acting on the debris, the diaphragm of the shield body and other portions of the tunneling machine can be reduced.

The properties of the shield type tunneling machine will become apparent from the following detailed description taken in conjunction with the drawings which indicate embodiments of the shield type tunneling machine.

Fig. 1 is a longitudinal sectional view showing a shield propelling device according to the present invention;

Fig. 2 is a small scale sectional view taken along the line 2—2 in Fig. 1; and

Fig. 3 is a small scale end view as viewed in the direction of the line 3—3 in Fig. 1.

As shown in Fig. 1, a shield type tunneling machine 10 according to the present invention includes a shield body 12 having a front portion 12a, intermediate portion 12b and rear portion 12c and a generally conical rotary head 16 disposed in a space 14 within the front portion 12a of the shield body. When the tunneling machine 10 is used for a pipe jacking operation, as is well known to the skilled in the art, a plurality of pipes made of steel or concrete (not shown) are connected to each other behind the shield body 12 and adjacent to the rearmost pipe is connected a hydraulic jack (not shown) disposed in a shaft to give a thrust to these pipes.

The front portion 12a of the shield body 12 has the bore converging gradually rearward and an inner peripheral surface 18 surrounds the space 14. The intermediate portion 12b behind the front portion 12a of the shield body 12 is provided with

a diaphragm 20 crossing the shield body. In the intermediate portion 12b of the shield body 12 are disposed a plurality of direction correcting jacks 22 (only one of the jacks is shown in Fig. 1) behind the diaphragm 20.

A crankshaft 24 for supporting and turning eccentrically the rotary head 16 is provided. A shaft portion 25a at one end side of the crankshaft 24 is journaled by a pair of roller bearings 28 attached to a collar 26 mounted on the diaphragm 20. Also, the shaft portion 25a is keyed on an output shaft 31 of a drive mechanism 30 including a motor and a reduction gear fixed through a bracket 29a to the diaphragm 20 by bolts 29b. On the other hand, a shaft portion 25b at the other end side of the crankshaft 24 journals the rotary head 16 through a pair of roller bearings 32 attached to the rotary head 16. The crankshaft 24 has an eccentricity e (see Figs. 1 and 2) between the shaft portions 25a and 25b.

A pair of pipes 34, 36 extending through the diaphragm are mounted on a lower portion of the diaphragm 20. Both pipes 34, 36 are opened toward the front of the diaphragm to communicate to a debris chamber 38 formed in front of the diaphragm 20 in the intermediate portion 12b of the shield body. The pipe 34 is a liquid supply pipe for supplying liquid such as muddy water and clean water to the front of the diaphragm 30, and the pipe 36 is a drain pipe for discharging surplus water in the ground and debris such as earth and sand together with liquid supplied to the front of the diaphragm. The debris may be discharged by a screw conveyor known per se in place of the liquid transportation.

An internal gear 40 is mounted on the diaphragm 20 and an external gear 42 meshing with the internal gear 40 is mounted on the rotary head 16 respectively. In the embodiment shown, the internal gear 40 is provided on an inner peripheral surface of a cylindrical member 44 having a flange 43. The cylindrical member 44 is fixed to the diaphragm 20 by bolts 46 extending through the flange 43. On the other hand, the external gear 42 is provided on an outer peripheral surface of the cylindrical member 48 having a flange 47. The cylindrical member 48 is fixed to the rotary head 16 by bolts 50 extending through the flange 47. The crankshaft 24, internal gear 40 and external gear 42 rotated by the drive mechanism 30 constitute a planetary gear mechanism. When the crankshaft 24 is rotated, the rotary head 16 carries out the eccentric turning motion, and at the same time it is rotated forcibly by the engagement of the internal gear 40 with the external gear 42. The rotational direction of the rotary head 16 at that time is opposite to that of the crankshaft 24. Said eccentric turning motion of the rotary head 16 is a revolution around the axis of the shaft portion 25a of the crankshaft 24. Said rotation of the rotary head 16 is one around its own axis.

As shown in Figs. 1 and 3, the rotary head 16 is provided with a cutter assembly 60 fixed to the end portion. In the embodiment shown, the cutter assembly 60 includes a plurality of spokes 62

disposed radially from the rotary head 16 and a plurality of bits or tips 64 provided on the respective spokes. Instead of said embodiment a cutter assembly (not shown) known per se may be provided which includes a disk having at least a slit and a plurality of bits or tips projecting from said slit forward. The cutter assembly 60 is not needed when the tunneling machine 10 is used for the soft ground and may, in that case, be removed before cutting starts.

To improve the function of the rotary head 16 for crushing the debris, especially gravel a plurality of projections 66, 68 having respective pointed ends are provided on the inner peripheral surface 18 of the front portion 12a of the shield body and on the outer peripheral surface 17 of the rotary head 16. The projections 66, 68 may be provided continuously or intermittently on said inner and outer peripheral surfaces 18, 17 in the circumferential direction or provided spirally, continuously or intermittently.

The tunneling machine 10 is provided with a seal device 70 for sealing between the rotary head 16 and the diaphragm 20. The seal device 70 includes a ring 72 and a coil spring 74. The ring 72 is disposed on an outer periphery of the cylindrical member 48 in an inner peripheral groove 75 opened at the rear of the rotary head 16. The ring 72 can be moved axially with respect to the crankshaft 24. On an outer periphery of the ring 72 is disposed an O-ring 76. The coil spring 74 is disposed in a hole 77 communicating to the inner peripheral groove 75 to press the ring 72 against the end face of the cylindrical member 44 and accomplish the sealing effect between the ring and the cylindrical member. Since the ring 72 is always pressed against the cylindrical member 44 by the spring 74 in said seal device 70, the sealing effect between both members can be maintained for a long time even if the ring 72 and the cylindrical member 44 wear at the contact area. Instead of the embodiment shown, the ring of said seal device may be disposed on the diaphragm 20 side to accomplish the sealing effect between the ring and the cylindrical member 48. In either case, between the ring 72 and the cylindrical member 44 lubricating oil, is supplied, stored in an oil bath 80 through paths 82, 84, 86 and 88, the bearing 28 and a path 90.

In the embodiment shown, the shield body 12 has the front portion 12a having the bore converging gradually rearward. While the rotary head 16 disposed in the front portion is generally conical, a frustoconical may be used instead of the conical rotary head.

Hereinafter the operation of the tunneling machine 10 will be described. When the crankshaft 24 is rotated by the drive mechanism 30, the rotary head 16 is turned with an eccentricity e from the center of the shield body 12. The turning direction is the same as the rotational direction of the crankshaft 24. As the rotary head 16 is turned, the rotary head 16 will be revolved around the shaft portion 25b of the crankshaft 24 in the opposite direction to that of the crankshaft

24 since the engaging position of the external gear 42 fixed to the rotary head 16 with the internal gear 40 fixed to the diaphragm 20 is moved sequentially. Under this condition, when the thrusting jack (not shown) gives a thrust to the concrete pipe from the rear, the tunneling machine 10 advances and excavates the face so that debris such as earth and sand received in the shield body 12 is condensed between the rotary head 16 and the shield body 12 and sent rearward. Thus, the debris reaching the debris chamber 38 is discharged through the pipe 36 to the rear of the diaphragm 20.

According to the present invention, the rotary head turning and revolving in the opposite direction to the turning direction of the crankshaft and the whole inner peripheral surface of the shield body condense the debris received between them to linearly move and guide the debris to the drain port. Therefore, the friction acting between the debris, the diaphragm of shield body and other parts of the tunneling machine can be reduced. As a result, a relatively compact drive unit can be used to rotate the rotary head and the cutter assembly. When the present invention is applied to the shield type tunneling machine for the pipe jacking method, the compact drive unit, i.e. the small diameter shield body can be realized.

Claims

1. A shield type tunneling machine (10) comprising:

a shield body (12) having a front portion (12a)
a diaphragm (20) provided in the rear of the front portion (12a) to cross the shield body (12).

a crank shaft (24) rotatably journaled by the diaphragm (20) and having one end connected to a drive mechanism (30) provided in the rear of the diaphragm (20) and the other end extending to the front of the diaphragm (20);

a conical or frusto-conical rotary head (16) supported rotatably by the other end of the crank shaft (24) and disposed in the front portion of the shield body (12);

a gear mechanism for rotating forcibly and eccentrically the rotary head (16); and

means (34, 36) for discharging debris from the front area of the diaphragm (20) to a rear area; characterized in that

the gear mechanism includes an internal gear (40) fixed to either the diaphragm (20) or the rotary head (16) and an external gear (42) fixed to the other;

the internal diameter of the front portion (12a) decreases in the rearward direction;

the internal surface (18) of the front portion (12a) is provided with a plurality of projections (66) and the outer surface (17) of the rotary head (16) is provided with a plurality of projections (68).

the rearwardly converging inner peripheral surface (18) of the front portion (12a) and the outer peripheral surface (17) of the rotary head

(16) acting together for crushing the debris and transporting it towards a discharge opening into a debris chamber (38).

2. A shield type tunneling machine as claimed in claim 1, comprising means (70) for sealing a gap between said diaphragm and said rotary head, said means being provided in one of said diaphragm and said rotary head and including a ring (72) movable axially with respect to said crankshaft and a spring (74) for deviating said ring to the other of said diaphragm and said rotary head.

3. A shield type tunneling machine as claimed in claim 1, wherein the projections (68) on the outer surface (17) of the rotary head (16) have respective pointed ends.

4. A shield type tunneling machine as claimed in claim 1, wherein the projections (66) on the internal surface (18) of the front portion (12a) have respective pointed ends.

5. A shield type tunneling machine as claimed in claim 1, comprising a cutter assembly (60) provided on a front end of said rotary head.

Patentansprüche

1. Schildvortriebstunnelbohrmaschine (10) mit: einem Schildkörper (12) mit einem vorderen Abschnitt (12a);

einer hinter dem vorderen Abschnitt (12a) vorgesehenen Trennwand (20), die durch den Schildkörper (12) geht;

einer Kurbelwelle (24), die drehbar von der Trennwand (20) gelagert ist und ein Ende mit einem Antriebsmechanismus (30), der hinter der Trennwand (20) vorgesehen ist, verbunden hat, und wobei sich das andere Ende vor die Trennwand (20) erstreckt;

einem konischen oder kegelformartigen Drehkopf (16), der drehbar von dem anderen Ende der Kurbelwelle (24) getragen ist und in den vorderen Abschnitt des Schildkörpers (12) gebracht ist;

einem Getriebemechanismus zum zwangweisen und exzentrischen Drehen des Drehkopfes (16); und

einer Vorrichtung (34, 36) zum Wegfördern von Abraum von der Vorderseite der Trennwand (20) nach einer hinteren Seite;

dadurch gekennzeichnet, daß der Getriebemechanismus ein entweder an der Trennwand (20) oder dem Drehkopf (16) befestigtes innenverzahntes Rad (40) und ein an dem anderen befestigtes außenverzahntes Rad (42) aufweist;

der innere Durchmesser des vorderen Abschnittes (12a) in die rückwärtige Richtung abnimmt;

die innere Oberfläche (18) vorderen Abschnittes (12a) mit einer Mehrzahl von Vorsprüngen (66) versehen ist und die äußere Oberfläche (17) des Drehkopfes (16) mit einer Mehrzahl von Vorsprüngen (68) versehen ist,

wobei die rückwärts abnehmende innere umlaufende Oberfläche (18) des vorderen

24 since the engaging position of the external gear 42 fixed to the rotary head 16 with the internal gear 40 fixed to the diaphragm 20 is moved sequentially. Under this condition, when the thrusting jack (not shown) gives a thrust to the concrete pipe from the rear, the tunneling machine 10 advances and excavates the face so that debris such as earth and sand received in the shield body 12 is condensed between the rotary head 16 and the shield body 12 and sent rearward. Thus, the debris reaching the debris chamber 38 is discharged through the pipe 36 to the rear of the diaphragm 20.

According to the present invention, the rotary head turning and revolving in the opposite direction to the turning direction of the crankshaft and the whole inner peripheral surface of the shield body condense the debris received between them to linearly move and guide the debris to the drain port. Therefore, the friction acting between the debris, the diaphragm of shield body and other parts of the tunneling machine can be reduced. As a result, a relatively compact drive unit can be used to rotate the rotary head and the cutter assembly. When the present invention is applied to the shield type tunneling machine for the pipe jacking method, the compact drive unit, i.e. the small diameter shield body can be realized.

Claims

1. A shield type tunneling machine (10) comprising:

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a crank shaft (24) rotatably journaled by the diaphragm (20) and having one end connected to a drive mechanism (30) provided in the rear of the diaphragm (20) and the other end extending to the front of the diaphragm (20);

a conical or frusto-conical rotary head (16) supported rotatably by the other end of the crank shaft (24) and disposed in the front portion of the shield body (12);

a gear mechanism for rotating forcibly and eccentrically the rotary head (16); and

means (34, 36) for discharging debris from the front area of the diaphragm (20) to a rear area; characterized in that

the gear mechanism includes an internal gear (40) fixed to either the diaphragm (20) or the rotary head (16) and an external gear (42) fixed to the other;

the internal diameter of the front portion (12a) decreases in the rearward direction;

the internal surface (18) of the front portion (12a) is provided with a plurality of projections (66) and the outer surface (17) of the rotary head (16) is provided with a plurality of projections (68).

the rearwardly converging inner peripheral surface (18) of the front portion (12a) and the outer peripheral surface (17) of the rotary head

(16) acting together for crushing the debris and transporting it towards a discharge opening into a debris chamber (38).

2. A shield type tunneling machine as claimed in claim 1, comprising means (70) for sealing a gap between said diaphragm and said rotary head, said means being provided in one of said diaphragm and said rotary head and including a ring (72) movable axially with respect to said crankshaft and a spring (74) for deviating said ring to the other of said diaphragm and said rotary head.

3. A shield type tunneling machine as claimed in claim 1, wherein the projections (68) on the outer surface (17) of the rotary head (16) have respective pointed ends.

4. A shield type tunneling machine as claimed in claim 1, wherein the projections (66) on the internal surface (18) of the front portion (12a) have respective pointed ends.

5. A shield type tunneling machine as claimed in claim 1, comprising a cutter assembly (60) provided on a front end of said rotary head.

Patentansprüche

1. Schildvortriebstunnelbohrmaschine (10) mit: einem Schildkörper (12) mit einem vorderen Abschnitt (12a);

einer hinter dem vorderen Abschnitt (12a) vorgesehenen Trennwand (20), die durch den Schildkörper (12) geht;

einer Kurbelwelle (24), die drehbar von der Trennwand (20) gelagert ist und ein Ende mit einem Antriebsmechanismus (30), der hinter der Trennwand (20) vorgesehen ist, verbunden hat, und wobei sich das andere Ende vor die Trennwand (20) erstreckt;

einem konischen oder kegelförmigen Drehkopf (16), der drehbar von dem anderen Ende der Kurbelwelle (24) getragen ist und in den vorderen Abschnitt des Schildkörpers (12) gebracht ist;

einem Getriebemechanismus zum zwangweisen und exzentrischen Drehen des Drehkopfes (16); und

einer Vorrichtung (34, 36) zum Wegfördern von Abraum von der Vorderseite der Trennwand (20) nach einer hinteren Seite;

dadurch gekennzeichnet, daß

der Getriebemechanismus ein entweder an der Trennwand (20) oder dem Drehkopf (16) befestigtes innenverzahntes Rad (40) und ein an dem anderen befestigtes außenverzahntes Rad (42) aufweist;

der innere Durchmesser des vorderen Abschnittes (12a) in die rückwärtige Richtung abnimmt;

die innere Oberfläche (18) vorderen Abschnittes (12a) mit einer Mehrzahl von Vorsprüngen (66) versehen ist und die äußere Oberfläche (17) des Drehkopfes (16) mit einer Mehrzahl von Vorsprüngen (68) versehen ist,

wobei die rückwärts abnehmende innere umlaufende Oberfläche (18) des vorderen



Abschnittes und die äußere umlaufende Oberfläche (17) des Drehkopfes (16) zum Zerdrücken des Abraumes zusammenwirken und ihn zu einer Entleerungsöffnung in eine Abraumkammer transportieren.

2. Schildvortriebstunnelbohrmaschine nach Anspruch 1, mit einer Einrichtung (70) zum Abdichten einer Lücke zwischen der Trennwand und dem Drehkopf, wobei die Einrichtung in einem der Trennwand oder des Drehkopfes vorgesehen ist und einen Ring (72), der axial in Bezug auf die Kurbelwelle bewegbar ist, und eine Feder (74) zum Ablenken des Ringes zu dem anderen der Trennwand und des Drehkopfes aufweist.

3. Schildvortriebstunnelbohrmaschine nach Anspruch 1, bei der die Vorsprünge (68) auf der äußeren Oberfläche (17) des Drehkopfes (16) entsprechende angespitzte Enden aufweisen.

4. Schildvortriebstunnelbohrmaschine nach Anspruch 1, bei der die Vorsprünge (66) auf der inneren Oberfläche (18) des vorderen Abschnittes (12a) entsprechende angespitzte Enden aufweisen.

5. Schildvortriebstunnelbohrmaschine nach Anspruch 1, mit einer Schneidevorrichtung (60), die auf dem vorderen Ende des Drehkopfes vorgesehen ist.

Revendications

1. Foreuse de tunnels, du type à bouclier (10) comprenant:

un corps de bouclier (12) possédant une partie avant (12a);

un diaphragme (20) prévu dans l'arrière de la partie avant (12a) pour s'étendre en travers du corps de bouclier (12);

un vilebrequin (24) porté libre en rotation par le diaphragme (20) et ayant une extrémité qui est accouplée à un mécanisme d'entraînement (30) prévu en arrière du diaphragme (20) et l'autre extrémité qui s'étend jusqu'à l'avant du diaphragme (20);

une tête rotative conique ou tronconique (16) portée libre en rotation par l'autre extrémité du vilebrequin (24) et disposée dans la partie avant du corps de bouclier (12);

un mécanisme à engrenages servant à faire

tourner à force et excentriquement la tête rotative (16); et

des moyens (34, 36) destinés à évacuer les déblais de la région avant du diaphragme (20) à une région arrière, caractérisée en ce que

le mécanisme à engrenages comprend une roue dentée à denture intérieure (40) fixée, soit au diaphragme (20) soit à la tête rotative (16), et une roue dentée à denture extérieure (42) fixée à l'autre de ces deux éléments;

le diamètre intérieur de la partie avant (12a) décroît vers l'arrière;

la surface interne (18) de la partie avant (12a) est munie d'une pluralité saillies (66) et la surface externe (17) de la tête rotative (16) est munie d'une pluralité de saillies (68);

la surface périphérique interne (18) de la partie avant (12a) qui converge vers l'arrière, et la surface périphérique extérieure (17) de la tête rotative (16) coopérant entre elles pour broyer les déblais et les transporter vers une ouverture de déchargement qui débouche dans une chambre à déblais (38).

2. Foreuse de tunnels du type à bouclier selon la revendication 1, caractérisée en ce qu'elle comprend des moyens (70) destinés à fermer à joint étanche un intervalle libre compris entre ledit diaphragme et ladite tête rotative, lesdits moyens étant prévus dans l'un des deux éléments constitués par ledit diaphragme et ladite tête rotative et comprenant une bague (72) mobile dans la direction axiale par rapport audit vilebrequin et un ressort (74) destiné à pousser ladite bague vers l'autre des deux éléments, le diaphragme ou la tête rotative.

3. Foreuse de tunnels du type à bouclier selon la revendication 1, caractérisée en ce que les saillies (68) de la surface externe (17) de la tête rotative (16) possèdent des extrémités pointues.

4. Foreuse de tunnels du type à bouclier selon la revendication 1, caractérisée en ce que les saillies (66) de la surface interne (18) de la partie avant (12a) possèdent des extrémités pointues.

5. Foreuse de tunnels du type à bouclier selon la revendication 1, caractérisée en ce qu'elle comprend un ensemble de coupe (60) prévu sur l'extrémité avant de la tête rotative.

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