

## Description

This invention relates to a shield tunneling machine using a tubular shield body of the kind known from FR-A-2275637.

Since a shield tunneling machine using a tubular shield body uses segments as reaction bodies when advancing the shield body, it cannot be applied to the excavation not using segments like that of bedrock layer. Further, said segments were sometimes subjected to an unreasonable force to be broken down in the advancing of the shield body.

An object of the present invention is to provide a shield tunneling machine which can be used for either of the excavation using segments and that not using segments and prevent the segments from an unreasonable force and thus breakage.

The shield tunneling machine according to the present invention comprises a shield body provided with a tubular head portion and a tubular tail portion disposed behind the head portion, a plurality of thrusting jacks for interconnecting said head portion and tail portion and moving the head and tail portions to or away from each other, a cutter head disposed in the front portion of said shield body, a rotary mechanism for rotating the cutter head and a plurality of position-maintaining mechanisms disposed in the shield body and having press bodies capable of projecting outward of the shield body, wherein said thrusting jacks are provided with a cylinder having a first and a second cylinder chamber, a first piston disposed in said first cylinder chamber, a second piston disposed in said second cylinder chamber, a first piston rod having one end connected to the first piston and a second piston rod having one end connected to said second piston.

In the tunneling machine according to the present invention, the shield body is provided with the head portion and the tail portion which are interconnected by a plurality of thrusting jacks for moving the head and tail portions to and away from each other. The position maintaining mechanism having press bodies capable of projecting outward of the shield body is provided in the shield body so that the press bodies of said position maintaining mechanism can be projected to make the natural ground around the shield body a reaction body. Thus, the tunneling machine can be used for either of the excavation using the segments and the excavation not using same and the segments are not subjected to any unreasonable force causing damages thereof.

The other objects and features of the present invention will become apparent from the following description of preferred embodiments of the invention with reference to the accompanying drawings.

Fig. 1 is a longitudinal sectional view showing an embodiment of a shield tunneling machine according to the present invention;

Fig. 2 is a sectional view taken along the line II—II in Fig. 1;

Fig. 3 is a sectional view taken along the line III—III in Fig. 1;

Fig. 4 is a longitudinal sectional view showing an embodiment of thrusting jack; and

Fig. 5 is an explanatory illustration of the operation of the shield body being advanced.

A shield tunneling machine is designated by reference numeral 10 in Figs. 1 and 2. The shield tunneling machine 10 comprises a tubular shield body 12, a plurality of thrusting jacks 14 disposed in the shield body, a cutter head 16 disposed in the front portion of said shield body 12, a rotary mechanism 18 for rotating the cutter head and a plurality of position-maintaining mechanisms 20 disposed in the shield body 12.

The shield body 12 is provided with a tubular head portion 22 and a tubular tail portion 24 disposed behind the head portion 22. The rear end of the head portion 22 has the diameter smaller than that of the front end and is inserted into the front end of the tail portion 24. Between the head portion 22 and the tail portion 24 is disposed a seal member 26 for allowing the head portion 22 and the tail portion 24 to move relatively to each other in the axial direction of the shield body 12.

In the front end of the head portion 22 are provided a partition wall 30 and a diaphragm 32 defining a muck chamber 28. The partition wall 30 is spaced forward from the diaphragm 32. In the tail portion 24 is provided an annular rib 34.

The thrusting jack 14 is a pneumatic or hydraulic jack for advancing and retreating a piston rod with pneumatic or hydraulic pressure. In the embodiment shown in Fig. 3, eight jacks are disposed in the shield body 12 at equal intervals.

Each thrusting jack 14, as shown in Fig. 4, comprises a cylinder 40 including first and second cylinder chambers 36, 38 having the center axes parallel to each other, a first piston 42 disposed in the first cylinder chamber 36 to be movable along said center axis, a second piston 44 disposed in the second cylinder chamber 38 to be movable along said center axis, a first piston rod 46 having one end connected to the first piston 42 and the other end projecting from the first cylinder chamber 36 in one direction of said center axis and a second piston rod 48 having one end connected to the second piston 44 and the other end projecting from the second cylinder chamber 38 in the opposite direction to said first piston rod 42.

The cylinder chamber 36, piston 42 and piston rod 46 constitute a thrusting jack section for advancing the shield body 12. The cylinder chamber 38, piston 44 and piston rod 48 constitute a direction correcting jack section for correcting the advancing direction of the shield body 12. Thus, the first cylinder chamber 36 has the axial length, i.e., the stroke of the piston, longer than that of the second cylinder chamber 38.

Each thrusting jack 14, as shown in Fig. 1, has an end of the first piston rod 46 pivotably connected to a connecting body 50 provided on the diaphragm 32 and an end of the second piston rod 48 connected to the rib 34 through a connecting body 52.

The cutter head 16 is provided with a boss 56 secured by a key 54 to an end of a rotary shaft 68 in the rotary mechanism 18, which will be later described, a face plate 58 following the front portion of the boss and a plurality of scrapers 60 extending radially from the back of the face plate.

On the central portion of the front surface of the face plate 58 are provided a plurality of center bits 62. The face plate 58 is provided with a plurality of openings arranged radially in rows in an outer periphery of said central portion. In each opening is disposed rotatably a roller bit 66. Each scraper 60 is connected to the boss 56 and the face plate 58.

Further, the face plate 58 is provided on an outer periphery of said central portion with a plurality of slits (not shown) extending radially of the face plate 58 and on both opposed side portions of the slit with cutter bits. Said roller bits 66 are used for excavating hard strata like bedrock layer. Said cutter bits are used for excavating soft strata like clay layer.

The rotary mechanism 18 is provided with said rotary shaft 68 rotatably journaled by the partition wall 30 and the diaphragm 32, a plurality of reversible motors 70, a reduction gear 72 connected to the output shaft of the motor, a gear 74 mounted on the output shaft, a large gear 76 meshing with the gear 74. The motor 70 and the reduction gear 72 are mounted on a gear case 78 fixed to the diaphragm 32. The large gear 76 is mounted on the rear end of the rotary shaft 68. In a gear case 78 is disposed a bearing 79 for preventing the rotary shaft 68 from moving axially.

As shown in Figs. 2 and 3, the position-maintaining mechanism 20 are disposed two by two in the head and tail portions 22, 24 of the shield body 12. Each position-maintaining mechanism 20 is provided with a position-maintaining jack 80 and a press body 82.

Each position-maintaining jack 80 is a jack for advancing and retreating the piston rod 80a with pneumatic or hydraulic pressure and secured to the shield body 12.

Each press body 82 is disposed in recesses 84 provided respectively in diametrically opposed portions of the head and tail portions 22, 24 of the shield body 12 and provided on an end of the piston rod of the position-maintaining jack 80. Also, each press body 82 is located in the recess 84 when the piston rod of the position-maintaining jack 80 is retreated into the cylinder and projects more outward than an outer peripheral surface of the shield body 12 when said piston rod is projected.

The partition wall 30 is formed on an upper portion with an opening 86. In the opening 86 is disposed a lid 88 hinged to the partition wall 30.

The lid 88 is connected through an arm 94 to a piston rod 92 of a cylinder 90 mounted on the diaphragm 32.

While the lid 88 normally closes the opening 86 with the cylinder 90, it is pivoted on the diaphragm 32 side against the pressure of the cylinder 90 to open the opening 86 for flowing earth and sand into the muck chamber 28 when the pressure of earth and sand received in a space between the partition wall 30 and the cutter head 16 exceeds the pressure set to the cylinder 90.

In the muck chamber 28 are disposed a rotor 96 and a stator 98 constituting a crusher for crushing relatively large conglomerate entering the muck chamber 28. The rotor 96 is mounted on the rotary shaft 68 and the stator 98 is mounted on the partition wall 30 below the rotor 96.

High pressure water is sent to the muck chamber 28 through a water supply pipe 100. Supplied water is discharged to the rear of the shield body 12 through a drain pipe 102 together with earth and sand in the muck chamber 28.

In the beginning of excavation, as shown in Fig. 5(A), the piston rods 46, 48 of each thrusting jack 14 are retreated into the cylinder 40.

Under this condition of the machine 10, the shield body 12 is subjected to the advancing force by each thrusting jack 14 while each motor 70 of the rotary mechanism 18 is rotated. The rotation of each motor 70 is transmitted to the face plate 58 through the reduction gear 72, gear 74, large gear 76 and rotary shaft 68 to rotate the cutter head 16. Thus, the machine 10 excavates the face while being advanced.

Excavated earth and sand enter the chamber in front of the partition wall 30 through said slits in the face plate 58 and then flow into the muck chamber 28 through the opening 86 in the partition wall 30 to be further discharged from the muck chamber 28 through the drain pipe 102 together with water. In a space formed in the rear of the shield body 12 by the advance of the shield body 12 is disposed a segment 104.

Next will be described the operation of the tunneling machine 10 being advanced.

#### (I) Straight advance of machine 10

First, the position-maintaining jack 80 of each position-maintaining mechanism 20 disposed in the tail portion 24 of the shield body 12 is operated and thereby the press body 82 is pressed against the natural ground around the shield body 12. Under this condition the piston rod 46 of each thrusting jack 14 is projected from the cylinder 40. Thus, the head portion 22 of the shield body 12 is advanced relatively to the tail portion 24. Then, the segment 104 is not made a reaction body, but the natural ground around the shield body 12 is made the reaction body, so that any unreasonable force is not applied to the segment 104.

Next, the position-maintaining jack 80 of each position-maintaining mechanism 20 disposed in the head portion 22 of the shield body 12 is operated and thereby the press body 82 is

press against the natural ground around the shield body 12. Under this condition the piston rod 46 of each thrusting jack 14 is retreated into the cylinder 40. Thus, the tail portion 24 of the shield body 12 is attracted to the head portion 22 side. Then, since the natural ground around the shield body is made the reaction body, the head portion 22 is not returned to the tail portion 24 side even if the frictional resistance between the head portion 22 and the natural ground is smaller than that between the tail portion 24 and the natural ground.

#### (II) Correction of advancing direction of machine 10

First, each position-maintaining jack 80 of the position-maintaining mechanism 20 disposed in the tail portion 24 of the shield body is operated and thereby the press body 82 is pressed against the natural ground around the shield body 12. Under this condition the piston rod 48 of the thrusting jack 14 located at the upper portion of the shield body 12 is projected from the cylinder 40. Thus, as shown in Fig. 5(B), the head portion 22 of the shield body 12 is inclined relative to the tail portion 24.

Next, the position-maintaining jack 80 of each position-maintaining mechanism 20 disposed in the tail portion 24 is operated and thereby the head portion 22 is inclined relative to the tail portion 24. Under this condition the piston rod 46 of each thrusting jack 14 is projected from the cylinder 40. Thus, as shown in Fig. 5(C), the head portion 22 of the shield body 12 is advanced while inclined relative to the tail portion 24.

When the piston rod 46 of each thrusting jack 14 is extended up, the position-maintaining jack 80 of each position-maintaining mechanism 20 disposed in the head portion 22 is operated in place of the position-maintaining jack 80 of each position-maintaining mechanism 20 disposed in the tail portion 24 to retreat the piston rod 46 of each thrusting jack 14 into the cylinder 40 with the press body 82 being pressed against the natural ground around the shield body 12.

Thus, while the tail portion 24 is attracted to the head portion 22 side, the head portion 22 is maintained inclined relative to the tail portion 24 as shown in Fig. 5(B). Thus, the shield body 12 is advanced along a curved path by the repetition of said processes.

#### (III) Straight readvance of shield body 12

The processes of said (I) will do after the piston rod 48 projecting from the cylinder 40 is retreated into the cylinder with each position-maintaining mechanism 20 disposed in the head portion 22 being operated.

#### Claims

1. A shield tunneling machine (10) comprising: a shield body (12) provided with a tubular head portion (22) and a tubular tail portion (24) disposed behind the head portion (22); a plurality of thrusting jacks (14) for inter-

connecting said head portion (22) and tail portion (24) and moving said head portion (22) and tail portion (24) to and away from each other;

a cutter head (16) disposed in front of said shield body (12);

a rotary mechanism (18) for rotating the cutter head (16); and

a plurality of position-maintaining mechanisms (20) disposed in said shield body (12) and each having a press body (82) capable of projecting outward of the shield body (12); characterized in that said thrusting jacks (14) are provided with a cylinder (40) having a first (36) and a second (38) cylinder chamber,

a first piston (42) disposed in said first cylinder chamber (36),

a second piston (44) disposed in said second cylinder chamber (38), a first piston rod (46) having one end connected to said first piston (42) and a second piston rod (48) having one end connected to said second piston (44).

2. A shield tunneling machine as claimed in claim 1, wherein the other end of said first piston rod (46) projects from said first cylinder chamber (36) in one direction of the center axis of said first cylinder chamber (36) and the other end of said second piston rod (48) projects from said second cylinder chamber (38) in the opposite direction of said first piston rod (46).

3. A shield tunneling machine as claimed in claim 1 or 2, wherein the center axes of said first (36) and said second (38) cylinder chambers are located on the same straight line.

4. A shield tunneling machine as claimed in one of claims 1 to 3, wherein the length in the direction of the center axis of said first cylinder chamber (36) is greater than that of said second cylinder chamber (38).

5. A shield tunneling machine (10) as claimed in one of claims 1 to 4, wherein one of said first (46) and second (48) piston rods is connected with one of said head portion (22) and tail portion (24) and the other piston rod with the other portion.

6. A shield tunneling machine (10) as claimed in one of claims 1 to 5, wherein said position-maintaining mechanism (20) includes respectively position-maintaining jacks (80) mounted on the inside of said shield body (12) and having a piston rod (80a) provided with said press body (82).

7. A shield tunneling machine (10) as claimed in one of claims 1 to 6 wherein said position-maintaining mechanism (20) is disposed in at least one of said head portion (22) and tail portion (24).

8. A shield tunneling machine (10) as claimed in one of claims 1 to 7, wherein the rear end of said head portion (22) has the diameter smaller than that of the front end of said tail portion (24) and is inserted into the front end of said tail portion (24).

9. A shield tunneling machine (10) as claimed in one of claims 1 to 8, wherein a seal member (26) is disposed between the rear end of said head portion (22) and the front end of said tail portion (24).

10. A shield tunneling machine (10) as claimed in one of claims 1 to 9, wherein said cutter head (16) is

supported by a rotary shaft (68) rotatably journalled by a partition wall (30) disposed in said head portion (22), and said rotary mechanism (18) is mounted on said head portion (22).

#### Patentansprüche

1. Schildvortriebsmaschine (10) mit:  
 einem Schildkörper (12), der mit einem röhrenförmigen Kopfabchnitt (22) und einem hinter dem Kopfabchnitt (22) angebrachten röhrenförmigen Schwanzabschnitt (24) versehen ist;  
 einer Mehrzahl von Druckzylindern (14) zum Verbinden des Kopfabchnittes (22) und des Schwanzabschnittes (24) und Bewegen des Kopfabchnittes (22) und des Schwanzabschnittes (24) zueinander und voneinander weg;  
 einem vor dem Schildkörper (12) angebrachten Schneidekopf (16);  
 einem Rotationsmechanismus (18) zum Drehen des Schneidekopfes (16); und  
 einer Mehrzahl von positionserhaltenden Mechanismen (20), die in dem Schildkörper (12) angebracht sind und von denen jeder einen Druckkörper (82) aufweist, der in der Lage ist, nach außen aus dem Schildkörper (12) hervorzustehen; dadurch gekennzeichnet,  
 daß die Druckzylinder (14) mit einem Zylinder (40) mit einer ersten (36) und einer zweiten (38) Zylinderkammer, mit einem in der ersten Zylinderkammer (36) angebrachten ersten Kolben (42), einem in der zweiten Zylinderkammer (38) angebrachten zweiten Kolben (44), einer ersten Kolbenstange (46), deren eines Ende mit dem ersten Kolben (42) verbunden ist, und einer zweiten Kolbenstange (48), deren eines Ende mit dem zweiten Kolben (44) verbunden ist, versehen sind.

2. Schildvortriebsmaschine nach Anspruch 1, bei der das andere Ende der ersten Kolbenstange (46) von der ersten Zylinderkammer (36) in eine Richtung der Mittelachse der ersten Zylinderkammer (36) vorsteht und das andere Ende der zweiten Kolbenstange (48) von der zweiten Zylinderkammer (38) in die entgegengesetzte Richtung der ersten Kolbenstange (46) vorsteht.

3. Schildvortriebsmaschine nach Anspruch 1 oder 2, bei der die Mittelachsen der ersten (36) und zweiten (38) Zylinderkammer auf der gleichen geraden Linie angeordnet sind.

4. Schildvortriebsmaschine nach einem der Ansprüche 1 bis 3, bei der die Länge in die Richtung der Mittelachse der ersten Zylinderkammer (36) größer ist als die der zweiten Zylinderkammer (38).

5. Schildvortriebsmaschine (10) nach einem der Ansprüche 1 bis 4, bei der eine der ersten (46) und zweiten (48) Kolbenstangen mit einem von dem Kopfabchnitt (22) oder dem Schwanzabschnitt (24) verbunden ist, und die andere Kolbenstange mit dem anderen Abschnitt.

6. Schildvortriebsmaschine (10) nach einem der Ansprüche 1 bis 5, bei der der positionserhaltende Mechanismus (20) entsprechende positionserhaltende Zylinder (80) aufweist, die auf

der Innenseite des Schildkörpers (12) angebracht sind und eine Kolbenstange (80a) aufweisen, die mit dem Druckkörper (82) versehen ist.

7. Schildvortriebsmaschine (10) nach einem der Ansprüche 1 bis 6, bei der der positionserhaltende Mechanismus (20) wenigstens in einem von dem Kopfabchnitt (22) und dem Schwanzabschnitt (24) angebracht ist.

8. Schildvortriebsmaschine (10) nach einem der Ansprüche 1 bis 7, bei der das hintere Ende des Kopfabchnittes (22) einen Durchmesser kleiner als der des vorderen Abschnittes des Schwanzabschnittes (24) aufweist und in das vordere Ende des Schwanzabschnittes (24) eingeführt ist.

9. Schildvortriebsmaschine (10) nach einem der Ansprüche 1 bis 8, bei der ein Dichtungselement (26) zwischen dem hinteren Ende des Kopfabchnittes (22) und dem vorderen Ende des Schwanzabschnittes (24) eingefügt ist.

10. Schildvortriebsmaschine (10) nach einem der Ansprüche 1 bis 9, bei der der Schneidekopf (16) durch eine Rotationswelle (68) getragen ist, die drehbar von einer in dem Kopfabchnitt (22) angebrachten Trennwand (30) getragen ist, und bei der der Rotationsmechanismus (18) an dem Kopfabchnitt (22) angebracht ist.

#### Revendications

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

un corps de bouclier (12) muni d'une partie de tête tubulaire (22) et d'une partie de queue tubulaire (24) disposée derrière la partie de tête (22);  
 une pluralité de vérins de poussée (14) destinés à relier ladite partie de tête (22) à ladite partie de queue (24) et à rapprocher et éloigner lesdites parties de tête (22) et de queue (24) l'une de l'autre;

une tête fraiseuse (16) disposée en avant dudit corps de bouclier (12);

un mécanisme rotatif (18) servant à faire tourner la tête fraiseuse (16); et

une pluralité de mécanismes de maintien en position (20) disposés dans ledit corps de bouclier (12) et dont chacun possède un sabot de serrage (82) capable de faire saillie à l'extérieur du corps de bouclier (12); caractérisée en ce que lesdits vérins de poussée (14) sont munis d'un cylindre (40) possédant une première chambre de cylindre (36) et une deuxième chambre de cylindre (38), un premier piston (42) disposé dans ladite première chambre de cylindre (36), un deuxième piston (44) disposé dans ladite deuxième chambre de cylindre (38), une première tige de piston (46) dont une extrémité est solidaire dudit premier piston (42), et une deuxième tige de piston (48) dont une extrémité est solidaire dudit deuxième piston (44).

2. Foreuse de tunnels à bouclier selon la revendication 1, caractérisée en ce que l'autre extrémité de ladite première tige de piston (46) émerge à l'extérieur de ladite première chambre de cylindre (36) dans un premier sens de l'axe

central: ladite première chambre de cylindre tandis que l'autre extrémité de ladite deuxième tige de piston (48) émerge hors de ladite deuxième chambre de cylindre (38) en sens inverse de ladite première tige de piston (46).

3. Foreuse à tunnels à bouclier selon la revendication 1 ou la revendication 2, caractérisée en ce que les axes centraux desdites première (36) et deuxième (38) chambres de cylindre sont placés sur la même ligne droite.

4. Foreuse de tunnels à bouclier selon une des revendications 1 à 3, caractérisée en ce que la longueur de ladite première chambre de cylindre (36), mesurée dans la direction de l'axe central est supérieure à celle de ladite deuxième chambre de cylindre (38).

5. Foreuse de tunnels à bouclier (10) selon une des revendications 1 à 4, caractérisée en ce que l'une des première (46) et deuxième (48) tiges de pistons est reliée à l'une desdites parties de tête (22) et partie de queue (24), tandis que l'autre tige de piston est reliée à l'autre partie.

6. Foreuse de tunnels à bouclier (10) selon une des revendications 1 à 5, caractérisée en ce que ledit mécanisme de maintien en position (20) comprend des vérins de maintien en position respectifs (80) montés à l'intérieur dudit corps de

bouclier (12) et possédant des tiges de pistons (80a) qui portent lesdits sabots de serrage (82).

7. Foreuse de tunnels à bouclier (10) selon une des revendications 1 à 6, caractérisée en ce que ledit mécanisme de maintien en position (20) est disposé dans au moins l'une des deux parties, la partie de tête (22) et la partie de queue (24).

8. Foreuse de tunnels à bouclier (10) selon une quelconque des revendications 1 à 7, caractérisée en ce que l'extrémité arrière de ladite partie de tête (22) possède un diamètre inférieur à celui de l'extrémité avant de ladite partie de queue (24) et est insérée dans l'extrémité avant de ladite partie de queue (24).

9. Foreuse de tunnels à bouclier (10) selon une des revendications 1 à 8, caractérisée en ce qu'un élément d'étanchéité (26) est disposé entre l'extrémité arrière de ladite partie de tête (22) et l'extrémité avant de ladite partie de queue (24).

10. Foreuse de tunnels à bouclier (10) selon une des revendications 1 à 9, caractérisée en ce que ladite tête fraiseuse (16) est supportée par un arbre rotatif (68) monté libre en rotation dans une cloison (30) disposée dans ladite partie de tête (22) et ledit mécanisme rotatif (18) est monté sur ladite partie de tête (22).

30

35

40

45

50

55

60

65

6