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Remarks:

A request for correction of the description has been filed pursuant to Rule 139 EPC. A decision on the request will be taken during the proceedings before the Examining Division (Guidelines for Examination in the EPO, A-V, 3.).

(54) **MOVABLE SHOVE FRAME STRUCTURE, DEVICE FOR STARTING TUNNELS AND METHOD FOR STARTING THE CONSTRUCTION OF TUNNELS**

(57) Movable shove frame structure, device for starting tunnels and method for starting the construction of tunnels. The movable shove frame structure (1) comprises:

- a shove frame (2) that comprises support legs (3),
- a shove ring (4) and
- a thrust ring (5) placed between the shove frame (2) and the shove ring (4),

- a gliding element (6) under each support leg (3) of the shove frame (2) and
- removable fixing means (7) to anchor the support legs (3) to the floor (8).

The method for making tunnels uses the device for starting tunnels and comprises a starting position, an advancement or pushing step, pulling steps, a cyclical repetition of pushing and pulling steps and a final step.

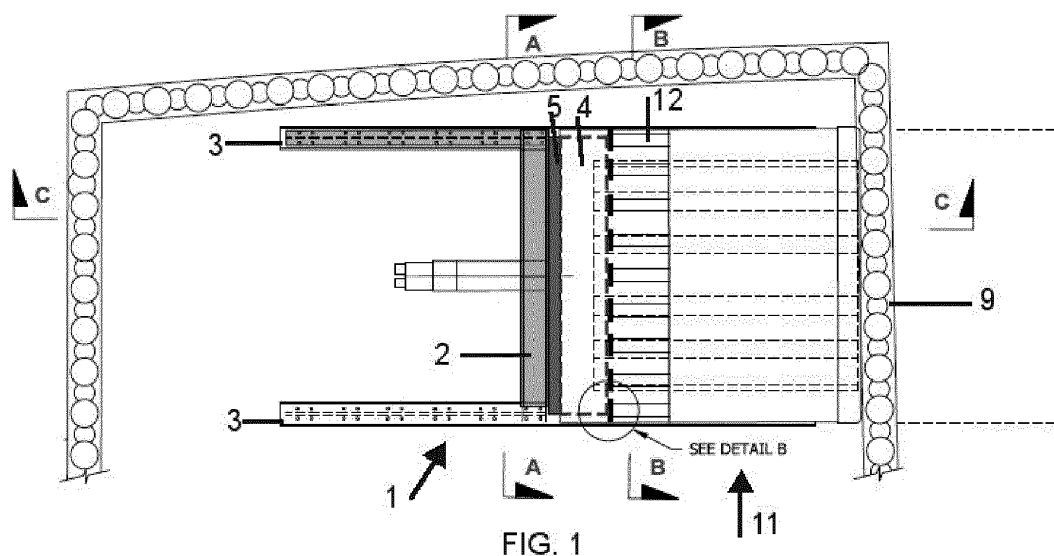


FIG. 1

Description

Field of the invention

[0001] This invention relates to a movable shove frame structure and a device for starting tunnels that comprises a movable shove frame structure. The invention also relates to a method for starting the construction of tunnels, that uses the device for starting tunnels.

[0002] In particular it refers to the launch, shove and initial burial of the tunnel boring machine.

Background of the invention

[0003] Mechanised tunneling are all the tunneling techniques in which excavation is performed mechanically, for instance with the use of a tunnel boring machine (TBM).

[0004] Currently it is common to use tunnel boring machines comprising a cutter head fitted to a shield body to power the excavation advancement and erect a tunnel lining to construct a tunnel.

[0005] Most of current shove frames for TBM launches are static rear braced heavy sectioned substantial steel works, and it takes a long time to install the associated base slab and frame amendments. Temporary precast "shove rings" are also required to facilitate TBM launch and burial, the shove rings also requiring additional temporary works to support them. All of this constitutes an impediment and means extended durations within the restricted confines of a shaft or a chamber.

[0006] EP 1650402 A1, referred to a "Method and apparatus for making tunnels by means of shield advancement", describes a method for shield approach for the manufacture of tunnel tubes by means of shield driving, whereby a tunnel boring machine is advanced through a transit opening of a driving wall, whereby the tractive forces of the tunnel boring machine during the heading are initiated in a thrust ring arranged behind the tunnel boring machine, of which the thrust ring is connected to the driving wall via tractive force transferring connecting elements and whereby the thrust ring is advanced by means of advancing elements arranged on the tractive force transferring connecting elements. This document also refers to an apparatus for shield approach for the manufacture of tunnel tubes by means of shield driving, whereby a tunnel boring machine is envisaged for the advancement through a transit opening of a driving wall, whereby a thrust ring is envisaged in which the approach forces of the tunnel boring machine are initiated during the heading, whereby the thrust ring is connected to the driving wall via tractive force transferring connecting elements and whereby the thrust ring is advanced by means of advancing elements arranged on the tractive force transferring connecting elements.

[0007] EP 1650402 A1 allows a particular method and apparatus for making tunnels using a "movable" shove frame with advantages over the prior art standard "static"

frames, the main concept being the utilization of the TBM propulsion cylinders to index forward the shove frame in a sequenced manner to aid TBM burial/launch. However, it still presents a series of disadvantages. For instance, it uses cable pulling techniques and a modified headwall to incrementally pull the shove frame forward. The tractive force transferring connecting elements (for instance, in the form of threaded rods) into a substantial chamber or shaft wall load bearing may be at risk of breakage, which can be a risk of accident for the people involved in the operations. In addition to this a homogeneous thrust is also difficult to achieve and alignment could deviate.

Summary of the invention

[0008] Accordingly, the object of the present invention is to provide a movable shove frame structure that avoids the mentioned drawbacks.

[0009] The invention provides a movable shove frame structure, comprising:

- a shove frame that comprises support legs,
- a shove ring and
- a thrust ring placed between the shove frame and the shove ring,

that additionally comprises a gliding element under each support leg of the shove frame and removable fixing means to anchor the support legs to the floor.

[0010] The invention also provides a device for starting tunnels comprising a movable shove frame structure of the invention and a tunnel boring machine that comprises several thrust cylinders that can be extended and retracted, wherein the thrust cylinders are attached to the shove ring of the movable shove frame structure by pulling means.

[0011] The invention also provides a method for starting the construction of tunnels, that uses a device for starting tunnels of the invention, that comprises the following steps:

- a) placement of the assembled tunnel boring machine in the starting position,
- b) placement of the assembled shove frame structure and anchoring the shove frame structure to the floor with removable fixing means,
- c) connection of the thrust cylinders of the tunnel boring machine to the shove ring by pulling means,
- d) the thrust cylinders of the tunnel boring machine are extended, pushing against the shove frame structure and making the tunnel boring machine advance a distance into the wall that coincides with the

extension of the thrust cylinders,

e) the fixing means anchoring the shove frame structure to the floor are released,

f) the thrust cylinders are retracted and the pulling means between the thrust cylinders of the tunnel boring machine and the shove ring pull the shove frame structure the distance corresponding to the advance of the thrust cylinders, such that the shove frame structure remains on the next anchoring position,

g) the shove frame structure is anchored to the floor with the removable fixing means,

h) repetition of the cycle of steps d) to g) several times until the shove frame structure reaches the shaft wall to allow commencement of the first permanent tunnel lining, and

i) final and reinforced anchoring of the shove frame to the floor.

[0012] The invention also provides several advantages with respect to the prior art:

- It removes the current impediments of chamber restrictions.
- It eliminates the requirement of having temporary shove rings and associated temporary works support.
- It simplifies temporary works and reduces launch duration.
- It reduces entrapment possibilities.
- It eliminates the tasks of extensive chamber modifications after TBM burial.
- It eliminates the latter removal of temporary shove rings.
- It eliminates the requirement to relocate tunnel services associated with traditional temporary shove rings.

[0013] Accordingly, the invention allows a device and a method for starting the constructions of tunnels which provides safety benefits, less activities, reduced durations and cost savings.

[0014] Other characteristics and advantages of the present invention will be clear from the following detailed description of several embodiments illustrative of its object in relation to the attached figures.

Brief description of the drawings

[0015]

Figure 1 is a plan view of the device of the invention comprising a tunnel boring machine and a movable shove frame structure and the wall to be excavated.

Figure 2A shows section A-A of Fig. 1.

Figure 2B shows detail A of Figure 2A.

Figure 3 shows section B-B of Fig. 1.

Figure 4 shows section C-C of Fig. 1.

Figure 5A shows a front view of the shove ring of the shove frame structure.

Figure 5B shows a side view of the shove ring of the shove frame structure.

Figure 6 shows an enlarged view of detail A of Fig. 5A.

Figure 7 shows an enlarged view of detail B of Figures 1 and 4.

Figure 8A shows a plan view of the device of the invention, once the TBM has been pushed forward for the first time.

Figure 8B shows section A-A of Fig. 8A.

Figure 9A shows a plan view of the device for making tunnels of the invention, once the shove frame assembly has been pushed forward for the first time.

Figure 9B shows section A-A of Fig. 9A.

Figure 10A shows a plan view of the device for making tunnels of the invention, once the TBM has been pushed forward for the second time.

Figure 10B shows section A-A of Fig. 10A.

Figure 11A shows a plan view of the device for making tunnels of the invention, once the shove frame structure has been pushed forward for the second time.

Figure 11B shows section A-A of Fig. 11A.

Figure 12A shows a plan view of the device for making tunnels of the invention, once the shove frame structure has been pushed forward to reach the shaft wall.

Figure 12B shows section A-A of Fig. 12A.

Detailed description of the invention

[0016] Figures 1 and 4 show the moveable shove frame structure 1 of the invention connected to a tunnel boring machine 11. These Figures 1 and 4 also show the wall 9 to be excavated.

[0017] The TBM shield body comprises several thrust cylinders 12 that can be extended and retracted.

[0018] The movable shove frame structure 1 comprises:

- a shove frame 2 that comprises support legs 3,
- a shove ring 4,
- a thrust ring 5 placed between the shove frame 2 and the shove ring 4,
- a gliding element 6 under each support leg 3 of the shove frame 2, and
- removable fixing means 7 to anchor the support legs 2 to the floor 8.

[0019] The shove frame 2 also comprises a number of steel beams, apart from the support legs 3 to be anchored to the floor 8.

[0020] In Figure 1 it can be seen that the shove frame structure 1 may comprise two parallel lateral support legs 3.

[0021] Figure 2A corresponds to section A-A of Figure 1 and shows the elements of the shove frame 2. Figure 3 corresponds to section B-B of Figure 1 and shows the cross section of the TBM 11. It also shows a cradle table 15 (preferably made of steel) on which the TBM 11 is placed.

[0022] The detail A in Figure 2A is enlarged in Figure 2B. In this Figure 2B it can be seen that the parallel support legs 3 of the shove frame 2 can be attached to the floor 8. A gliding element 6 is placed under each lateral support leg 3 of the shove frame 2 (in Figure 2B, it is a U-shaped sliding channel).

[0023] The gliding element 6 will have predefined anchoring points corresponding to the design and manufactured anchoring positions where the removable fixing means 7 can be placed, as can be seen in Figures 1 and 4.

[0024] The removable fixing means 7 may be, for instance, fixing bolts on cast in situ reaction sockets 14 within the structure floor 8.

[0025] Figures 5A and 5B show respectively a front view and a side view of the shove ring 4 of the shove frame structure 1.

[0026] Figure 7 shows an enlarged view of detail B of Figures 1 and 4, and it represents the attachment between a thrust cylinder 12 of the TBM 11 and the shove ring 4 of the shove frame structure 1. The thrust cylinders

12 are attached to the shove ring 4 by pulling means 13 (for instance, chains, as represented in Fig. 7). Other suitable pulling means 13 can be any other kind of connection between two elements like a welding or a bolted joint.

[0027] As for the thrust cylinders 12, they are placed in the periphery of the TBM 11 (as shown in Figure 3), and are arranged circumferentially and evenly spaced from each other.

[0028] The device of the invention is suitable for carrying out the method for starting tunnels that will be described next.

[0029] The method for starting the construction of tunnels according to the invention comprises the following steps:

Starting position (Figures 1 and 4):

[0030]

a) placement of the assembled tunnel boring machine 11 in the starting position,

b) placement of the assembled shove frame structure 1 and anchoring the shove frame structure 1 to the floor 8 with removable fixing means 7,

c) connection of the thrust cylinders 12 of the tunnel boring machine 11 to the shove ring 4 by pulling means 13,

Advancement step (Figures 8A and 8B):

[0031]

d) the thrust cylinders 12 of the tunnel boring machine 11 are extended, pushing against the shove frame structure 1 and making the tunnel boring machine 11 advance a distance into the wall 9 that coincides with the extension of the thrust cylinders 12,

Pulling steps (Figures 9A and 9B):

[0032]

e) the fixing means 7 anchoring the shove frame structure 1 to the floor 8 are released,

f) the thrust cylinders 12 are retracted and the pulling means 13 between the thrust cylinders 12 of the tunnel boring machine and the shove ring 4 pull the shove frame structure 1 the distance corresponding to the advance of the thrust cylinders 12, such that the shove frame structure 1 remains on the next anchoring position,

g) the shove frame 2 is anchored to the floor 8 with the removable fixing means 7,

Cyclical repetition of advancement and pulling steps (Figures 10A, 10B, 11A, 11B, 12A and 12B):

[0033]

h) repetition of the cycle of steps d) to g) several times until the shove frame structure 1 reaches the shaft wall to allow commencement of the first permanent tunnel lining, and

Final step (Figures 12A and 12B):

[0034]

i) final and reinforced anchoring of the shove frame 2 to the floor 8.

[0035] The final step allows to absorb the thrust force during excavation under the pressure of reinforcement of the anchoring of the shove frame 2 to the floor.

[0036] The distance d that the TBM 11 advances in each cycle of steps d) to g) can be predefined and will depend on the ring design length and associated thrust cylinders elongation. As an example, it can be comprised between 1,5 m and 2 m.

[0037] In Figures 9A and 9B the fixing bolts are refixed into the next set of pre-drilled through holes 10 of the gliding element 6 once the shove frame structure 1 is pushed forward the predefined distance.

[0038] Figures 8A and 8B correspond to a first advancement or pushing step in which the TBM 11 is pushed forwards a distance d, and Figures 10A and 10B correspond to a second advancement or pushing step in which the TBM 11 is pushed forwards a distance d.

[0039] Figures 9A and 9B correspond to a first pulling step in which the shove frame structure 1 is pushed forwards a distance d, and Figures 11A and 11B correspond to a second pulling step in which the shove frame structure 1 is pushed forwards a distance d.

[0040] As previously indicated, there is a cyclical repetition of pushing and pulling steps, until the shove frame structure 1 reaches the shaft wall. Figures 12A and 12B show the shove ring 4 in its final position

[0041] In the final position of the device the redundant excess gliding element 6 can be removed.

[0042] Although the present invention has been fully described in connection with preferred embodiments, it is evident that modifications may be introduced within the scope thereof, not considering this as limited by these embodiments, but by the contents of the following claims.

Claims

1. Movable shove frame structure (1), comprising:

- a shove frame (2) that comprises support legs (3),

- a shove ring (4) and
- a thrust ring (5) placed between the shove frame (2) and the shove ring (4),

5 **characterized in that** it additionally comprises a gliding element (6) under each support leg (3) of the shove frame (2) and removable fixing means (7) to anchor the support legs (3) to the floor (8).

10 2. Movable shove frame structure (1) according to claim 1, wherein the gliding elements (6) are channels.

3. Movable shove frame structure (1) according to claim 1 or 2, wherein the shove frame (2) comprises two parallel lateral support legs (3).

4. Movable shove frame structure (1), according to any of the previous claims, wherein the gliding elements (6) comprise several through holes (10) corresponding to the anchoring positions.

5. Movable shove frame structure (1), according to any of the previous claims, wherein the removable fixing means (7) to anchor the support legs (3) to the floor (8) are bolts.

6. Device for starting tunnels, comprising a movable shove frame structure (1) of any of claims 1 to 5 and a tunnel boring machine (11) that comprises several thrust cylinders (12) that can be extended and retracted, wherein the thrust cylinders (12) are attached to the shove ring (4) of the movable shove frame structure (1) by pulling means (13).

7. Device for starting tunnels, according to claim 6, wherein the pulling means (13) are chains.

8. Method for starting the construction of tunnels, that uses a device for starting tunnels of claims 6 or 7, that comprises the following steps:

a) placement of the assembled tunnel boring machine (11) in the starting position,
b) placement of the assembled shove frame structure (1) and anchoring the shove frame structure (1) to the floor (8) with removable fixing means (7),
c) connection of the thrust cylinders (12) of the tunnel boring machine (11) to the shove ring (4) by pulling means (13),
d) the thrust cylinders (12) of the tunnel boring machine (11) are extended, pushing against the shove frame structure (1) and making the tunnel boring machine (11) advance a distance into the wall (9) that coincides with the extension of the thrust cylinders (12),
e) the fixing means (7) anchoring the shove

frame structure (1) to the floor (8) are released,
f) the thrust cylinders (12) are retracted and the
pulling means (13) between the thrust cylinders
(12) of the tunnel boring machine (11) and the
shove ring (4) pull the shove frame structure (1) 5
the distance corresponding to the advance of
the thrust cylinders (12), such that the shove
frame structure (1) remains on the next anchor-
ing position,
g) the shove frame (2) is anchored to the floor 10
(8) with the removable fixing means (7),
h) repetition of the cycle of steps d) to g) several
times until the shove frame structure (1) reaches
the shaft wall to allow commencement of the first
permanent tunnel lining, and 15
i) final and reinforced anchoring of the shove
frame (2) to the floor (8).

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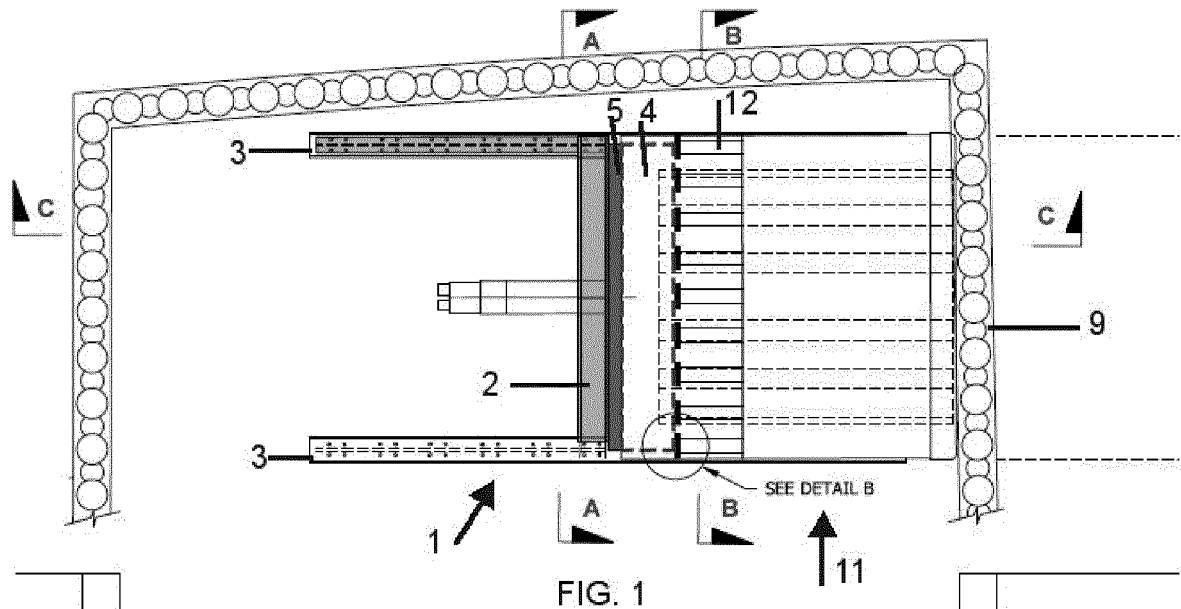


FIG. 1

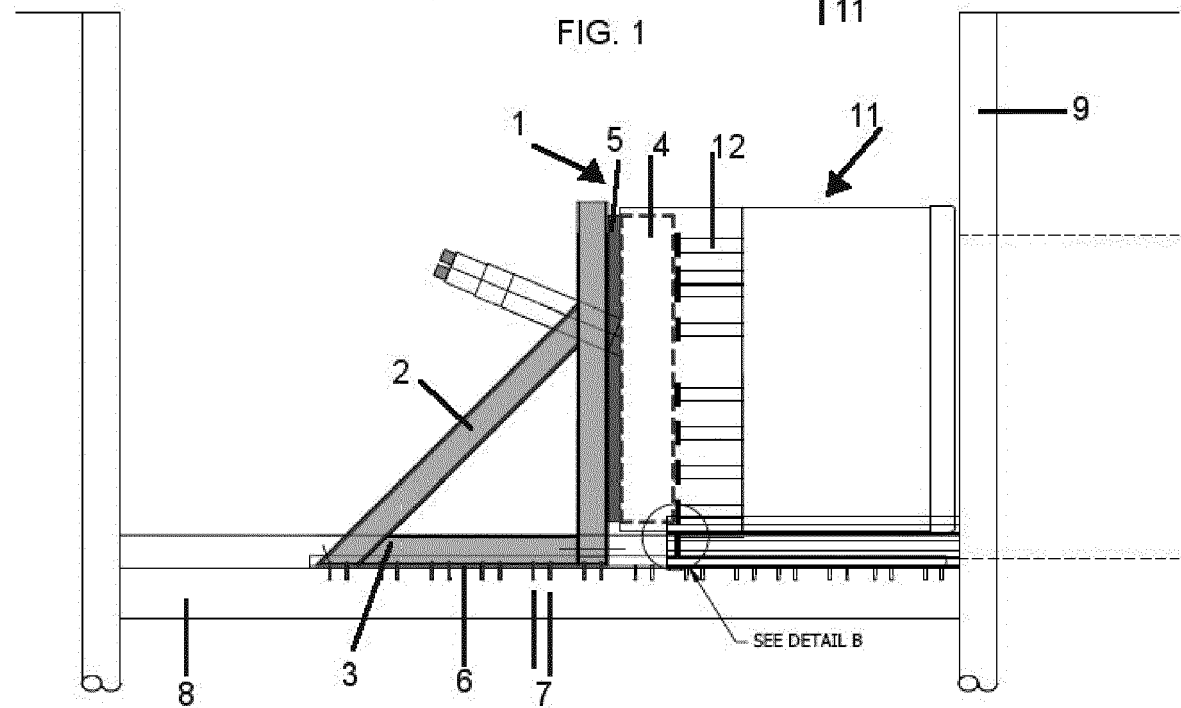
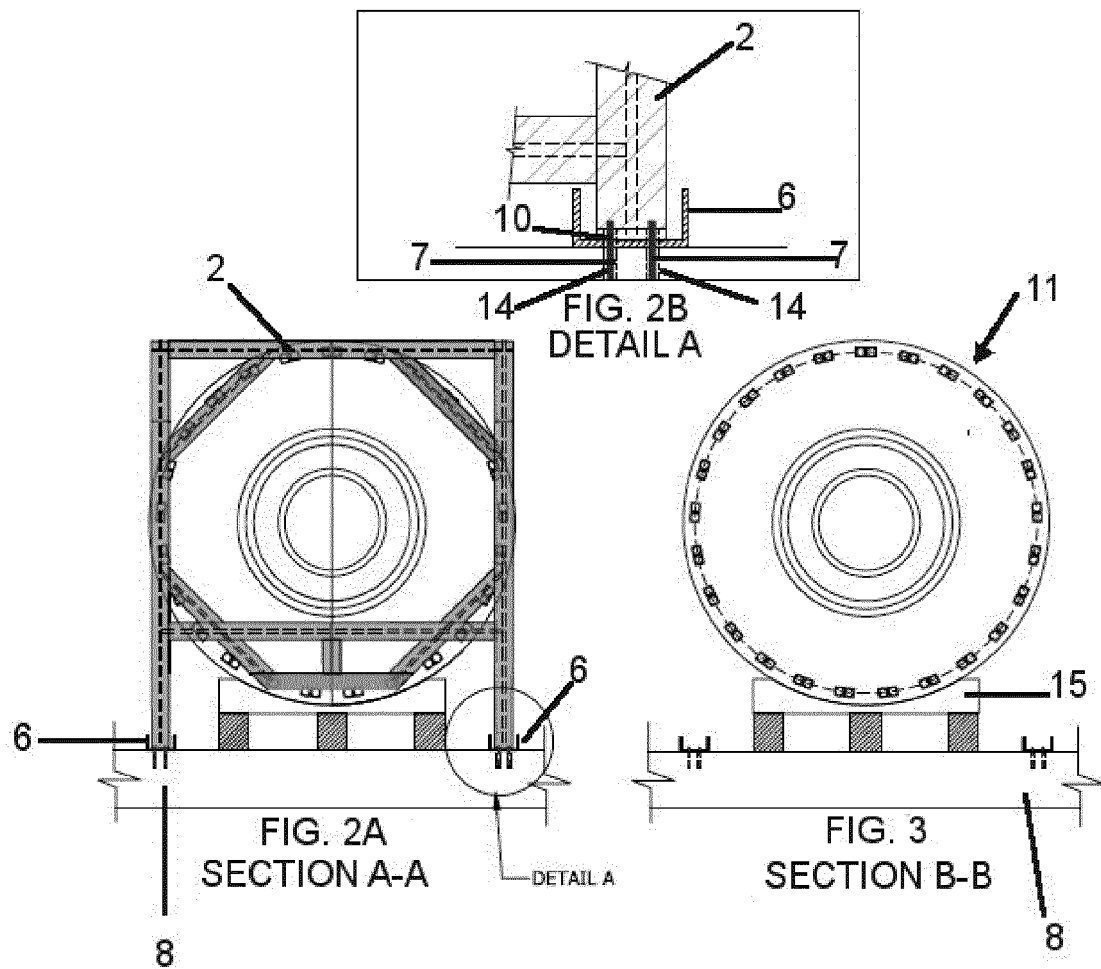


FIG. 4
SECTION C-C



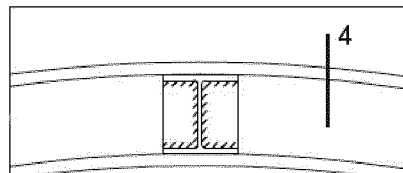
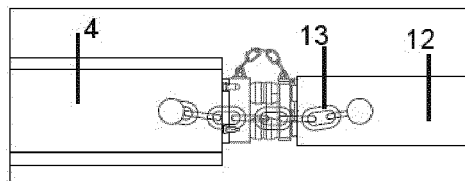


FIG. 6 DETAIL A'



DETAIL B FIG. 7

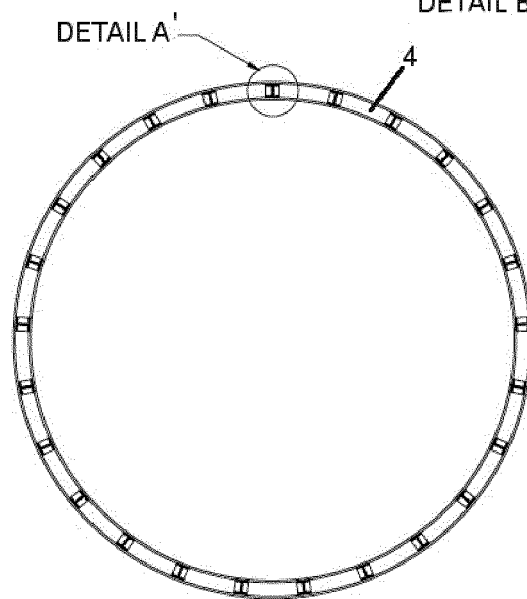


FIG. 5A

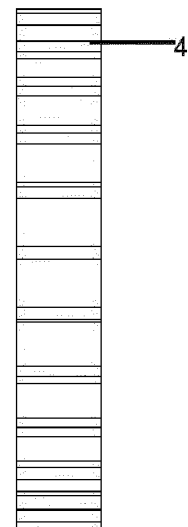
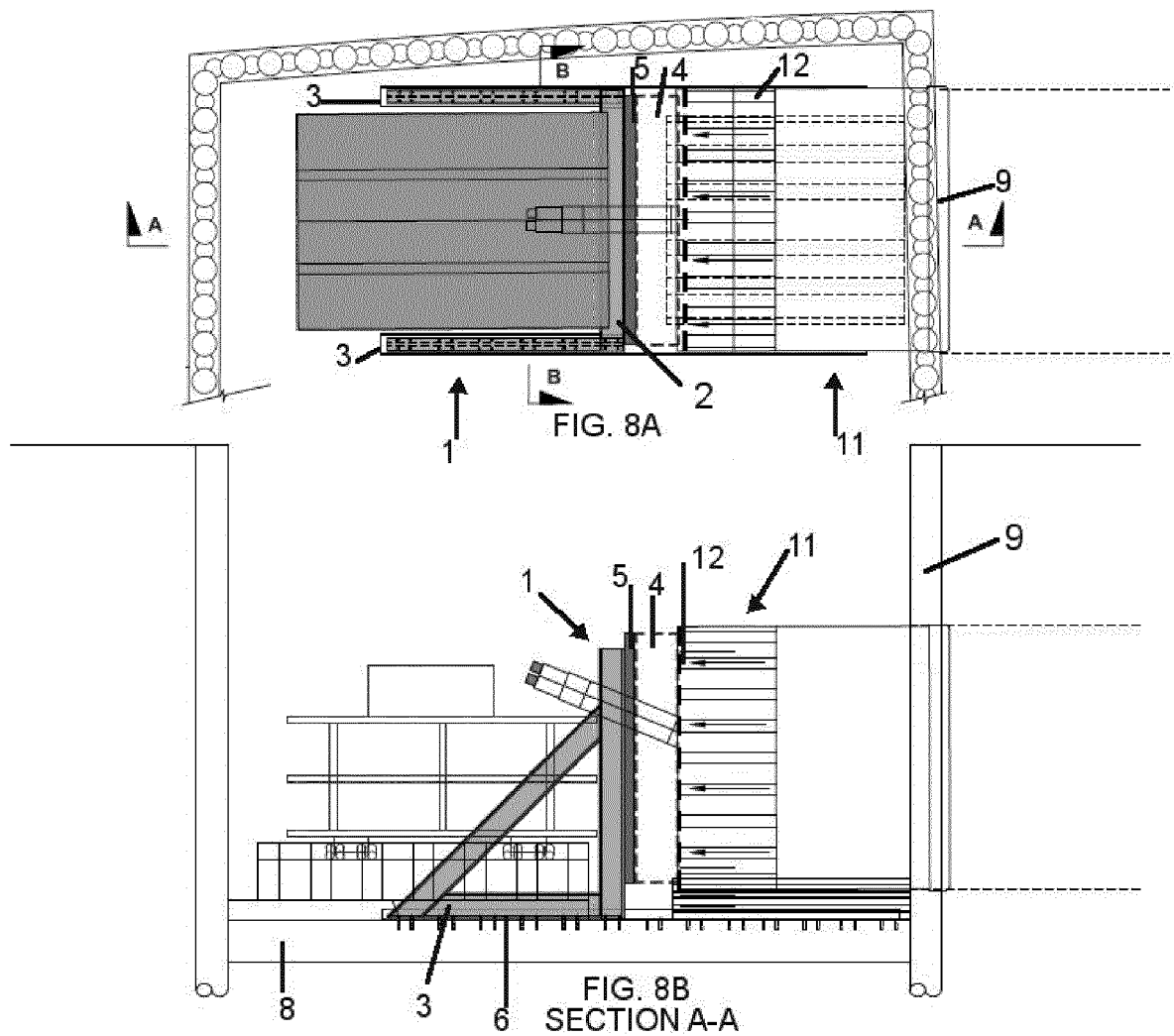
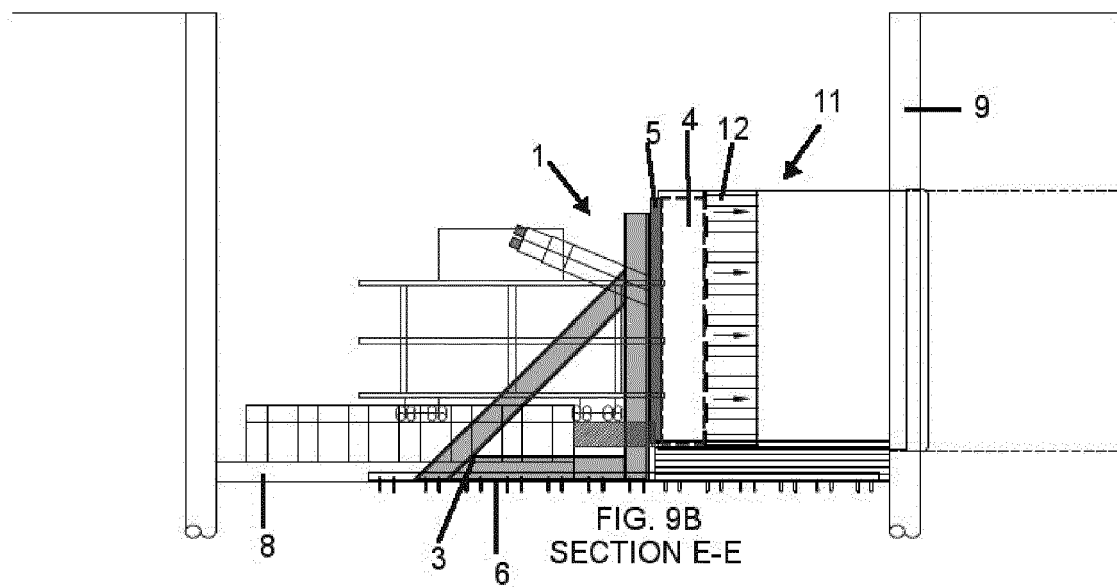
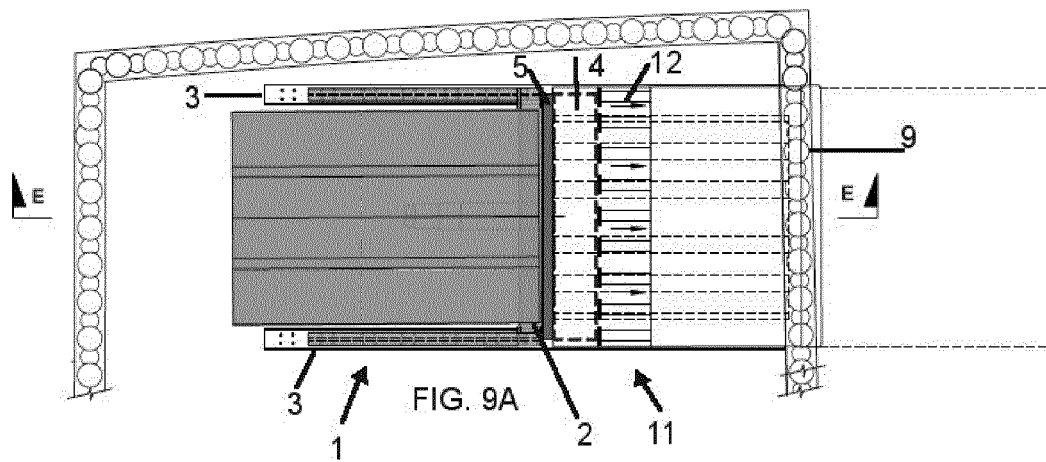
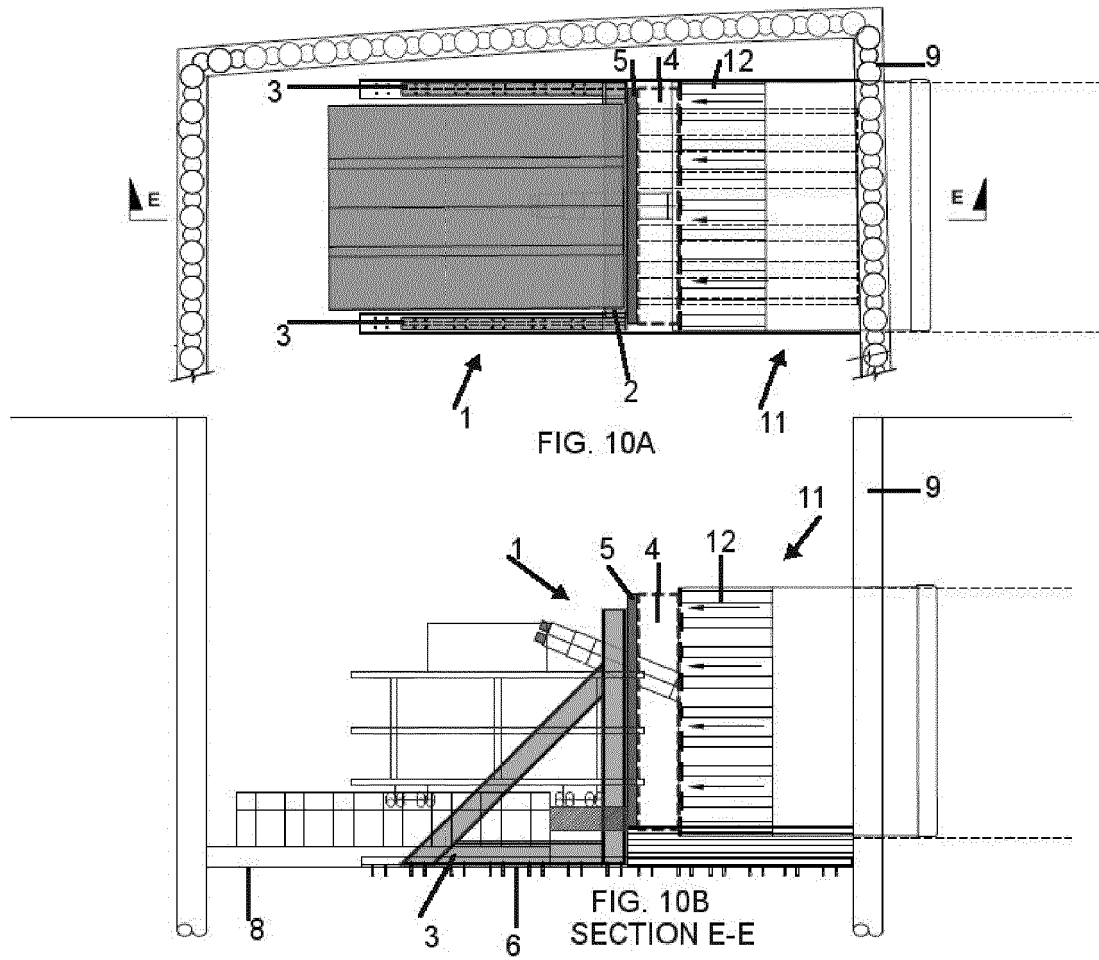
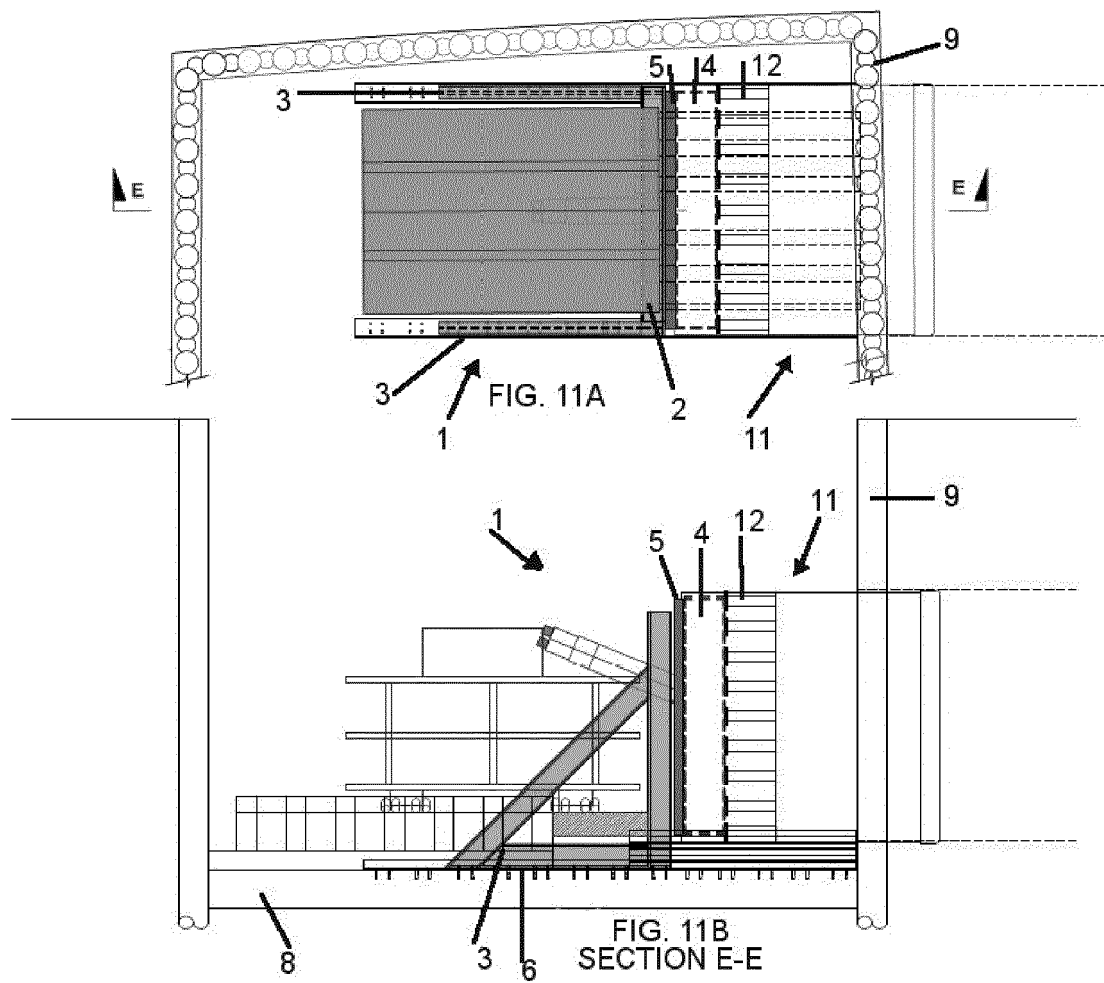


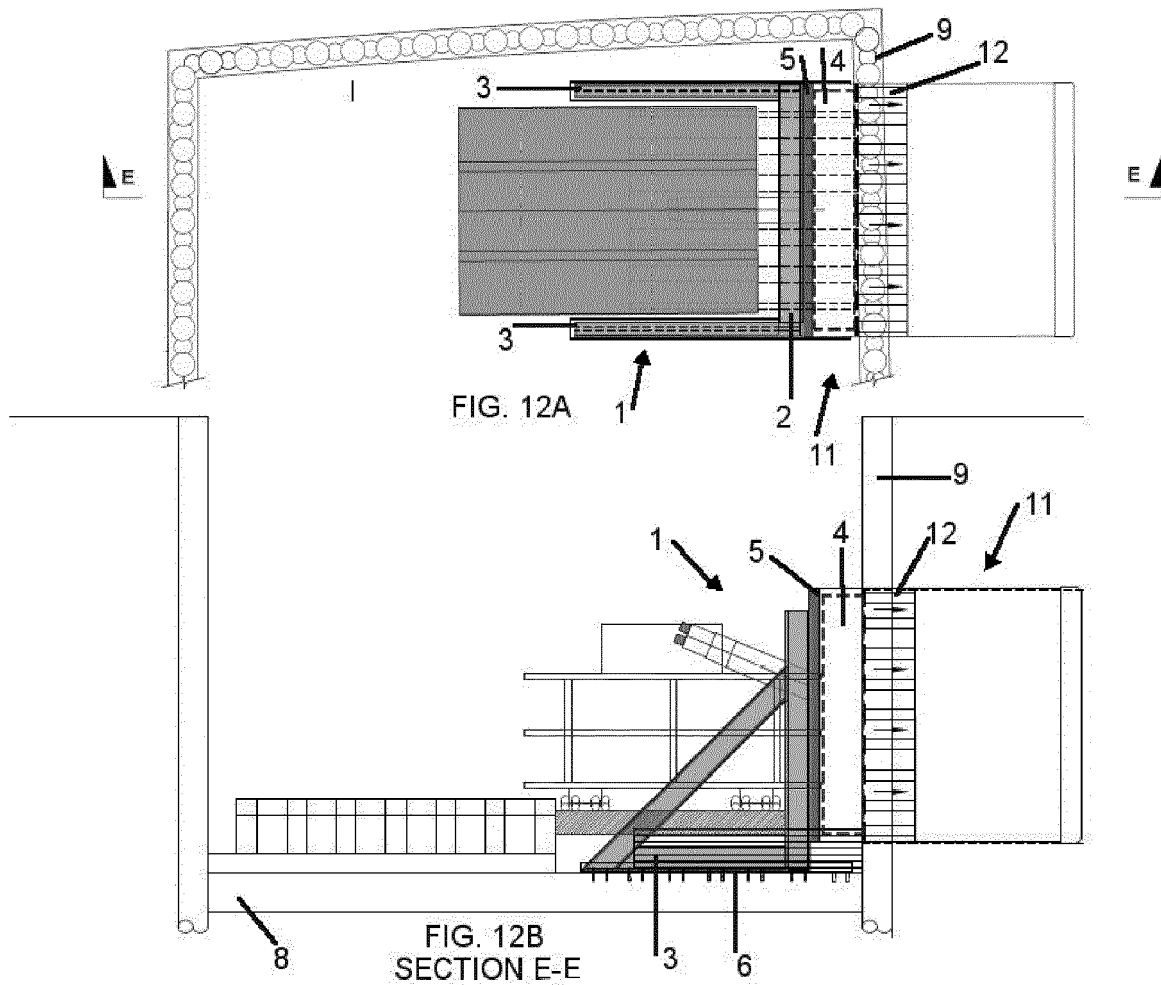
FIG. 5B













EUROPEAN SEARCH REPORT

Application Number
EP 18 19 6174

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DOCUMENTS CONSIDERED TO BE RELEVANT			
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			TECHNICAL FIELDS SEARCHED (IPC)
			E21D
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
The Hague		13 March 2019	Jucker, Chava
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EP 18 19 6174

5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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13-03-2019

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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