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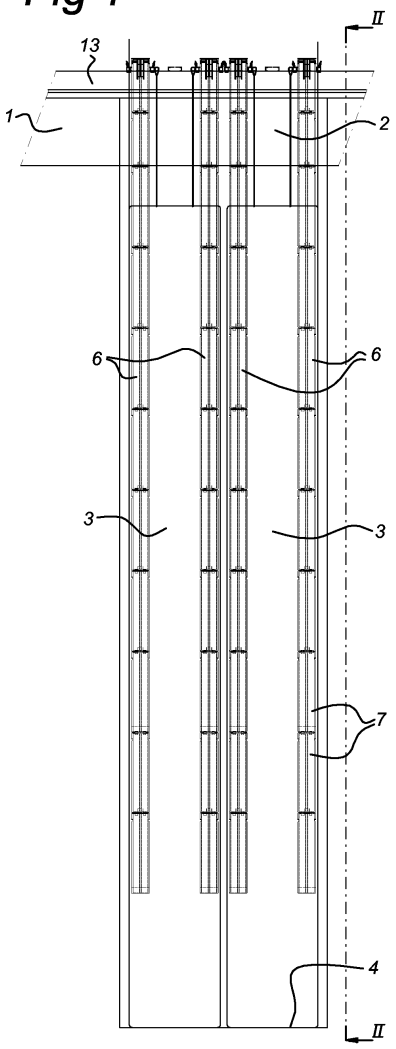
(54) Method for the construction of a diaphragm wall, as well as spacer

(57) A method for the construction of a diaphragm wall in a substrate (1), comprising the following steps:
- digging a trench (2) in the substrate (1),
- filling the trench (2) with a support liquid, such as bentonite,
- introducing reinforcement (3) into the trench (2),
- introducing a spacer (6) into the trench (2) in such a way that said spacer is located between the reinforcement (3) and a trench wall (5),
- pouring concrete mix into the trench (2),
- removing the spacer (6) from the trench (2) before the concrete mix has set.

Fig 1



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Description

[0001] The invention relates to the construction of a diaphragm wall in a substrate. Such a diaphragm wall can fulfil various functions. A diaphragm wall which is used for the building of a quay wall is mentioned as an example. A diaphragm wall of this type is excavated on one side in such a way that a harbour basin can be formed. Another example is a diaphragm wall which is used in the building of basements and the like, such as underground car parks.

[0002] The diaphragm wall is constructed by digging a trench in a substrate, which trench is filled with, for example, bentonite in order to prevent the trench walls from collapsing. Reinforcement is then placed in the trench thus produced, after which the concrete mix is poured that is then left to set. It is highly important in this regard that the reinforcement, which is usually made from steel, is thoroughly encased in the set concrete. As is known, steel is subject to intense rusting whenever it is exposed to oxygen, which must be prevented at all times. Affected parts in the reinforcement seriously weaken the concrete construction, in the present case the diaphragm wall.

[0003] With the aim of ensuring that the steel reinforcement is at all times incorporated sufficiently deeply in the concrete, spacers are fastened to the reinforcement. These may be plastic rings which are braced against the formwork within which the concrete is poured. The problem in the construction of diaphragm walls is that it is not possible for such plastic rings to be braced sufficiently in the trench. After all, there is no formwork in the trench, so the plastic rings would have to bear against the fairly soft trench wall. Under the effect of the heavy weight of the reinforcement, the plastic rings could easily be pressed into the trench wall, as a result of which the reinforcement still ends up on the surface of the finished diaphragm wall.

[0004] The cause of this pressing of the plastic rings into the trench wall is the high contact pressure. It would therefore be desirable to reduce said contact pressure by enlarging the bearing surface of the plastic rings. However, this is not feasible, because this would weaken the concrete construction.

[0005] The aim of the invention is therefore to provide a method of the aforementioned type wherein it can reliably be ensured that the reinforcement is incorporated in the set concrete in a sufficiently protected manner. This aim is achieved by means of a method for the construction of a diaphragm wall in a substrate, comprising the following steps:

- digging a trench in the substrate,
- filling the trench with a support liquid, such as bentonite,
- introducing reinforcement into the trench,
- introducing a spacer into the trench in such a way that said spacer is located between the reinforcement and a trench wall,
- pouring concrete mix into the trench,
- removing the spacer from the trench before the concrete mix has set.

[0006] The method according to the invention provides the advantage that the reinforcement is centred in the trench, as required, by the spacers. Said spacers can have a fairly large surface area: after all, they are removed before the concrete mix has set, so they do not detract from the cohesion of the finished concrete construction. On the other hand, said large contact surfaces prevent the spacers from being pressed into the soft trench wall. Although the spacers are removed before the concrete mix has set, this does not lead to problems, since by that stage the centred reinforcement, a portion of which has already been incorporated in the poured concrete mix, has achieved a fairly stable position.

[0007] As stated above, the spacers can be removed from the trench during the filling thereof with concrete mix. Preferably, in this respect a procedure is adopted in which the concrete mix is poured to a level in the trench such that the bottom end of the spacer(s) does not dip into the concrete mix, after which the pouring of concrete mix and the removal of the spacer(s) from the trench are then coordinated in such a way that the bottom end of the spacer(s) is continually kept from dipping into the concrete mix.

[0008] Such a procedure has the advantage that the concrete mix is able completely to fill the space in the trench around the reinforcement in a reliable manner. In fact it has to be borne in mind that the concrete mix has only moderate flow characteristics. Furthermore, the concrete mix starts to harden somewhat after it has been poured into the trench, which further hinders the reliable filling of the trench. If the bottom of the spacers were then to dip into the freshly poured concrete mix, there would be a risk that the entire space would not be completely filled. In this case, pockets of bentonite would remain, which pockets would lead to holes in the finished construction. By removing the spacers in such a way that they do not dip into the freshly poured concrete mix, the risk of pockets of bentonite is avoided.

[0009] The method according to the invention is particularly suitable for the construction of fairly deep diaphragm walls. In this case, the method includes the step of assembling the spacer(s) from successive spacer parts. This assembly is done during installation of the spacers in the trench. Conversely, the spacers are disassembled into the separate spacer parts during removal thereof from the trench.

[0010] The method according to the invention can further include installing support rails along the top edges of the trench, as well as suspension of the spacers from said support rails. As already stated above, in the case of a fairly deep diaphragm wall, the spacer will be assembled from separate spacer parts having a limited length. In this case, the already finished portion of the

spacer has to be temporarily supported every time so as then to allow the following spacer part to be fitted or else removed.

[0011] In this connection, the method according to the invention further includes the step of straddling a frame across the trench, as well as supporting the spacers on said frame during introduction of the spacers into the trench. In particular, said frame can be used in the assembly of the spacers from spacer parts, the supporting of each top spacer part on the frame, as well as the fastening of an additional spacer part to the top of the supported spacer part. In this case, the frame can be supported on the support rails.

[0012] As described above, the reinforcement is preferably introduced once the spacers have been introduced. However, this order could also be reversed.

[0013] The invention further relates to a spacer for use in the method as described above, having at least one essentially flat bearing surface which is intended for bracing against at least one of the trench walls. Said spacer may further have a guide surface which faces away from the bearing surface and which is intended to guide the reinforcement along it during the introduction thereof. The two faces are parallel to one another, in such a way that the spacers can easily be introduced into the trench.

[0014] The spacer is preferably assembled from a series of spacer parts coupled one after the other. The top end of the spacer can be provided with suspension hooks, whereas the bottom end, viewed in longitudinal section, is bevelled so that it becomes narrower or is made so that it recedes. The bottom end is therefore somewhat pointed, as a result of which said end is prevented from damaging the trench wall during the introduction of the spacer. For this reason, the longitudinal edges, viewed in cross-section, can also be bevelled so that they become narrower or are made so that they recede.

[0015] The invention further relates to a spacer part for a spacer as described above, having a bearing plate which forms part of the bearing surface of the spacer. Said spacer part can further have a guide plate which forms part of the guide surface of the spacer. With regard to coupling of the spacer parts together, coupling means are provided on the two opposing transverse edges thereof.

[0016] On the longitudinal edges of the spacer parts, suspension means can be provided for the temporary suspension of said spacer parts on the frame described above. These can, for example, be notches in the longitudinal edges.

[0017] The invention further relates to a frame for use in the method described above, having support means for supporting a spacer. Said frame can, in particular, have at least two support plates located opposite each other which can be rotated between a release position, in which the spacer can be moved up and down in the trench, and a locking position, in which the spacer and the relevant spacer part are suspended from the frame. The support plates engage in the notches in the spacer part in such a way that reliable suspension is ensured.

[0018] The invention will be explained in more detail below with reference to the drawings.

Figure 1 is a view of a trench with reinforcement and spacers according to the invention installed therein.
Figure 2 is a cross-section along II-II in Figure 1.
Figure 3 is a plan view of the trench according to Figure 1.
Figure 4 shows an enlarged detail of the plan view in Figure 3.
Figure 5 is a side view of Figure 4.
Figure 6 is the side view of Figure 5 during the introduction and removal of a spacer, respectively.
Figure 7 is a front view of a spacer part.
Figure 8 is a side view of the spacer part in Figure 7.
Figure 9 is a plan view of the spacer part in Figure 7.
Figure 10 is a side view of a top spacer part.
Figure 11 is a side view of a bottom spacer part.

[0019] Figures 1 - 3 illustrate a specific phase of the method according to the invention for the construction of a diaphragm wall. In this phase, a trench 2 is dug in the substrate 1. Two elongated reinforcements 3 are positioned in the trench 1 so as to reach the bottom 4 of the trench 2. In a subsequent phase, not shown, concrete mix is poured into the trench 2. It is important in this regard that the reinforcements 3 are completely encased by this concrete mix. This is necessary in order reliably to protect the reinforcements 3, which are made from steel, against corrosion.

[0020] In this connection it is necessary to keep the reinforcements 3 at all times at a certain distance from the walls 5 of the trench 2. It will be clear that this distance from the reinforcements 3 to the trench walls 5 must be maintained over the entire height. According to the invention this is achieved by means of the spacers 6, which are placed on either side against the trench walls 5. To that end the spacers 6 are lowered into the trench 2 and the reinforcements 3 are then placed between them.

[0021] Once the reinforcements 3 and the spacers 6 have been placed in the trench 2, the concrete mix can be poured. In this respect the procedure is firstly to pour an amount of concrete mix into the trench 2. During this procedure it is preferably ensured that the bottom end of the spacers 6 does not dip into the concrete mix. During further pouring of concrete mix into the trench 2, the spacers 6 are raised at regular intervals in such a way that the underside thereof remains at some distance above the concrete mix. This ensures complete filling of the trench around the reinforcement without pockets of bentonite being able to be formed. This does not present any problems for the position of the reinforcements 3, since these are already sufficiently stabilised by the amount of concrete mix poured in.

[0022] Once the finished trench 2 has been completely filled with concrete mix in this way, the spacers 6 are

removed and the concrete mix can set. The reinforcements 6 are completely encased in the concrete with this procedure, since during the pouring thereof they were kept at a distance from the trench walls 5 by means of the spacers 6.

[0023] Since the method according to the invention is suitable for the construction of deep diaphragm walls, it is important that the spacers 6 are each made up of separate spacer parts 7. Such a spacer part 7 is illustrated in Figures 7 - 9. Each spacer part 7 consists of a bearing plate 8 and a guide plate 9, which form a bearing surface and a guide surface, respectively. At the transverse edges 10 the spacer parts 7 are each provided with coupling sleeves 11, 12, by means of which the spacer parts can be fastened to one another. As can be seen in the plan view of Figure 9, the longitudinal edges of the spacer parts 7 are made somewhat receding so they become narrower. The purpose of this is to prevent the spacers 6 from damaging the trench walls 5 during introduction into and removal from the trench 2.

[0024] In Figures 1 - 6 it can be seen that support rails 13 are situated on the upper edges of the trench 2. The spacers 6 can be suspended from these support rails 13 by means of the hooks 14. As illustrated in Figure 4, the frame indicated in its entirety by reference numeral 15 can be placed on these support rails 13. This frame has two interconnected crossmembers 16, 16 on which the rotatable support plates 17 - in the illustrated embodiment, two pairs thereof - are mounted.

[0025] As illustrated in Figure 6, these support plates 17 each serve to support a spacer part 7. For this purpose the support plates 17 are rotated into the position illustrated in Figure 6 in such a way that they become situated in the notches 18 that are located in the longitudinal edges of the spacer part 7. In this situation, an additional spacer part 7 can be linked up or else detached. For this purpose the locking pins 19 illustrated in Figure 6 are inserted into or else removed from the coupling sleeves 11, 12.

[0026] Each spacer 6 can thus be assembled step by step, the support plates 17 being used in each case. Once an additional spacer part 7 has been linked up in the manner described above, the series of spacer parts 7 are raised somewhat in such a way that the support plates 17 can be rotated to the position illustrated in Figure 5. The series of spacer parts 7 can then be moved further downwards into the trench 2 and the then top spacer part 7 can again be supported by the support plates 17 with regard to the linking up of an additional spacer part 7, etc. During removal of the spacers 6 from the trench 2, the procedure is reversed.

[0027] Figure 10 shows on an enlarged scale the top spacer part 7', on the top of which there is a narrowed or otherwise receding portion 20. In addition, the hooks 13 are fixed to the guide surface 9 of the top spacer part 7'.

[0028] Figure 11 shows on an enlarged scale the bottom spacer part 7", which has a narrowing or receding portion 21 at the bottom. A shape of this type is suitable for preventing the trench walls 5 from becoming damaged during introduction of the spacer into the trench 2.

Claims

1. Method for the construction of a diaphragm wall in a substrate (1), comprising the following steps:

   - digging a trench (2) in the substrate (1),
   - filling the trench (2) with a support liquid, such as bentonite,
   - introducing reinforcement (3) into the trench (2),
   - introducing a spacer (6) into the trench (2) in such a way that said spacer is located between the reinforcement (3) and a trench wall (5),
   - pouring concrete mix into the trench (2),
   - removing the spacer (6) from the trench (2) before the concrete mix has set.

2. Method according to Claim 1, including introducing the reinforcement (3) between at least two spacers (6), which spacers (6) are each located next to an associated trench wall (5).

3. Method according to Claim 1 or 2, including removing the spacer(s) (6) from the trench (2) during filling of the trench (2) with concrete mix.

4. Method according to one of the preceding claims, including pouring the concrete to a level in the trench (2) such that the bottom end of the spacer(s) (6) does not dip into the concrete mix, as well as coordinating pouring concrete mix and removing the spacer(s) (6) from the trench (2) in such a way that the bottom end thereof is continually kept from dipping into the concrete mix.

5. Method according to one of the preceding claims, including introducing a plurality of spacers (6) on a single side of the reinforcement.

6. Method according to one of the preceding claims, including assembling the spacer(s) from successive spacer parts.

7. Method according to Claim 6, including assembling the spacer(s) (6) during the installation thereof in the trench (2).

8. Method according to Claim 6 or 7, including the step of disassembling the spacer(s) (6) during removal thereof from the trench (2).

9. Method according to one of the preceding claims, including stepwise removal of the spacer(s) (6) from the trench (2).

10. Method according to one of the preceding claims, including introducing at least one pouring pipe or tremie pipe in the trench almost as far as the bottom thereof, as well as pouring of the concrete mix through the pouring pipe.

11. Method according to one of the preceding claims, including installing a support rail (13) along a top edge of the trench (2), as well as suspending at least one spacer (6) from said support rail (13).

12. Method according to Claim 11, including installing one support rail (13) on both upper edges of the trench (2) in each case, as well as suspending spacers (6) from said two support rails (13).

13. Method according to one of the preceding claims, including straddling a frame (15) across the trench (2), as well as supporting the spacer(s) (6) on said frame (15) during introduction of the spacer(s) (6) into the trench (2).

14. Method according to Claim 13, including the assembly of the spacer(s) (6) from spacer parts (7), the supporting of each top spacer part on the frame (15), as well as the fastening of an additional spacer part to the top of the supported spacer part.

15. Method according to Claim 14, including supporting the spacer part (7) on both edges located opposite each other in the longitudinal direction of the trench (2).

16. Method according to one of Claims 13 - 15 when dependent on one of Claims 11 or 12, including supporting the frame (15) on the support rails (13).

17. Method according to one of the preceding claims, including installing the reinforcement (3) in the trench (2) once the spacers (6) have been introduced into the trench (2).

18. Spacer (6) for use in the method according to one of the preceding claims, having at least one essentially flat bearing surface (8) which is intended for bracing against at least one of the trench walls (5).

19. Spacer (6) according to Claim 18, having a guide surface (9) which faces away from the bearing surface (8) and which is intended to guide the reinforcement (3) along it.

20. Spacer (6) according to Claim 18 or 19, assembled from a series of spacer parts (7) coupled one after the other.

21. Spacer (6) according to one of Claims 18 - 20, wherein the top end (20) is provided with suspension hooks (13).

22. Spacer (6) according to one of Claims 18 - 21, wherein the bottom end (21), viewed in longitudinal section, is bevelled so that it becomes narrower.

23. Spacer (6) according to one of Claims 18 - 22, wherein the longitudinal edges (12), viewed in cross-section, are bevelled so that they become narrower.

24. Spacer part (7) for a spacer according to Claim 20, having a bearing plate (8) which forms part of the bearing surface.

25. Spacer part (7) according to Claim 24, having a guide plate (9) which forms part of the guide surface.

26. Spacer part (7) according to Claim 24 or 25, having two opposing transverse edges (10), which transverse edges are each provided with coupling means (11, 12).

27. Spacer part (7) according to Claim 26, wherein the coupling means comprise coupling sleeves (11, 12) positioned in a complementary manner.

28. Spacer part (7) according to one of Claims 24 - 27, having two opposing longitudinal edges (12), on which longitudinal edges suspension means (18) are provided for suspension from a frame (15).

29. Spacer part (7) according to Claim 28, wherein the suspension means comprise notches (18) in the longitudinal edges.

30. Spacer part (7) according to one of Claims 24 - 29, wherein the longitudinal edges (12), viewed in cross-section, are made so that they become narrower or are receding.

31. Spacer part (7") according to one of Claims 24 - 30, intended to be used at the bottom end of the spacer (6) according to Claim 21, having a bottom end (21) which, viewed in longitudinal section, is made so that it becomes narrower or is receding.

32. Spacer part (7') according to one of Claims 24 - 30, intended to be used at the top end of the spacer (6) according to Claim 20, having suspension hooks (13).

33. Frame (15) for use in the method according to one of Claims 13 - 16, having support means (17) for supporting a spacer (6).

34. Frame (15) according to Claim 32, for use with a spacer (6) which comprises spacer parts (7) according to Claim 28, having at least two support plates

(17) located opposite each other which can be rotated between a release position, in which the spacer (6) can be moved up and down in the trench (2), and a locking position, in which the spacer (6) and the relevant spacer part (7) are suspended from the frame (15).

35. Frame according to Claim 33, having two pairs of support plates (17) located opposite each other for supporting two spacers (6) parallel to and at some distance from each other.

Fig 1

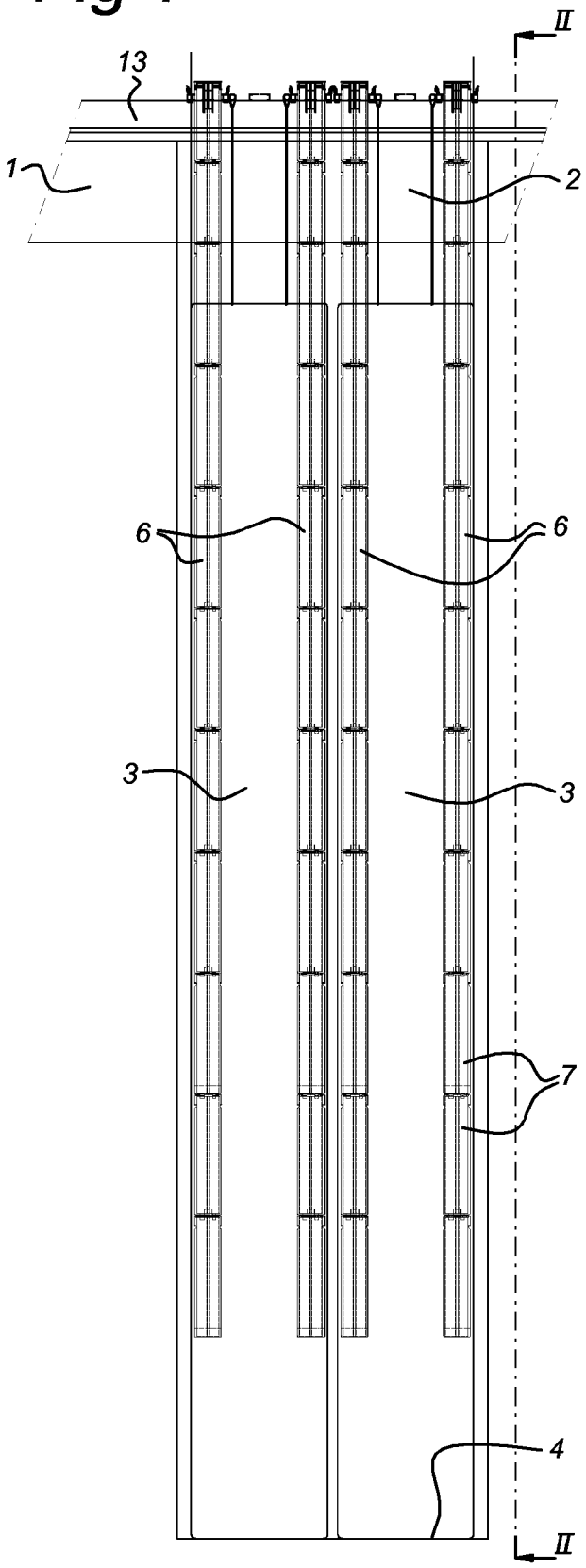


Fig 2

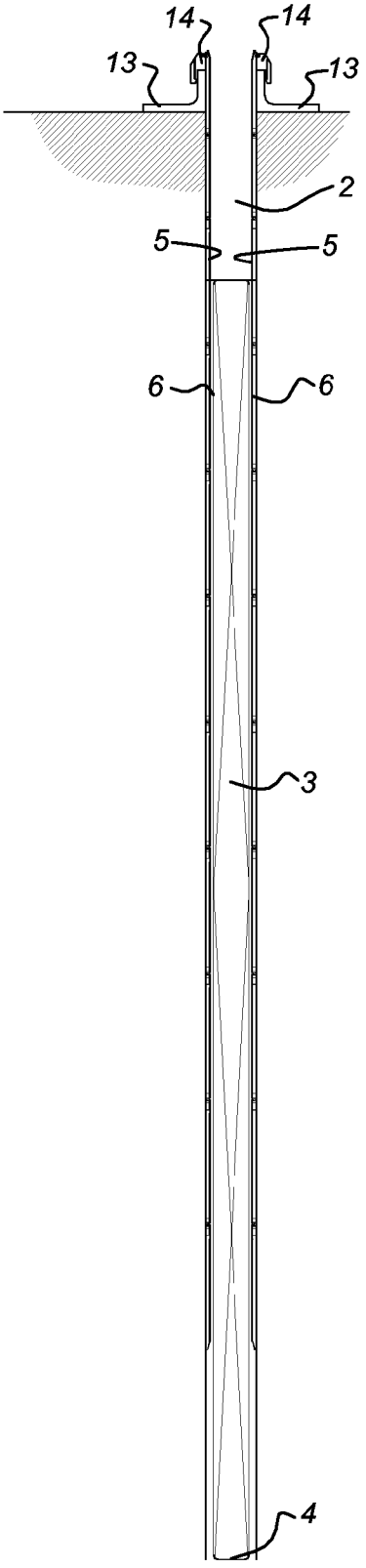


Fig 3

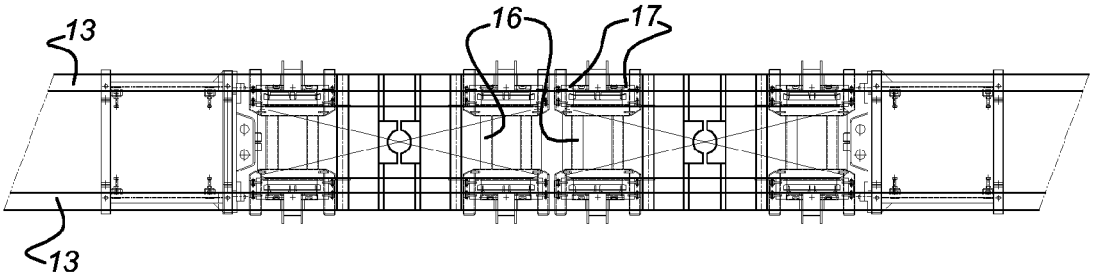


Fig 4

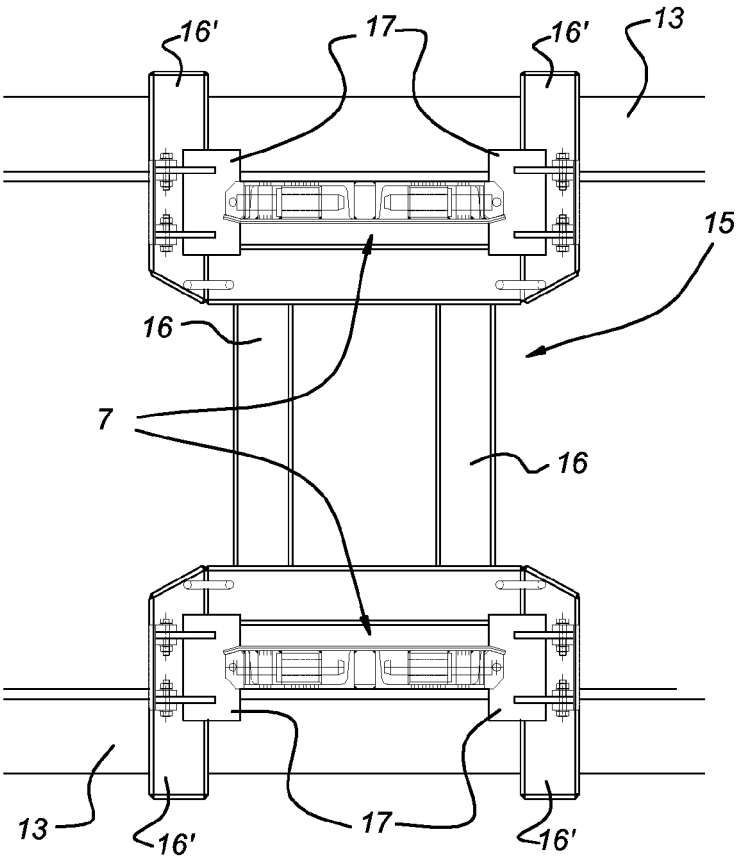


Fig 5

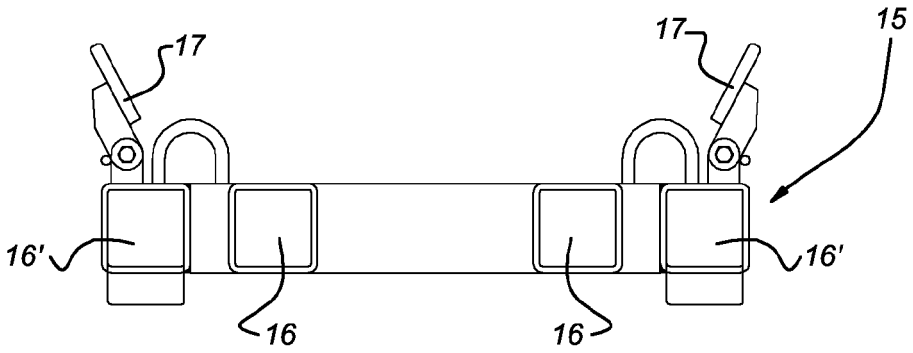


Fig 6

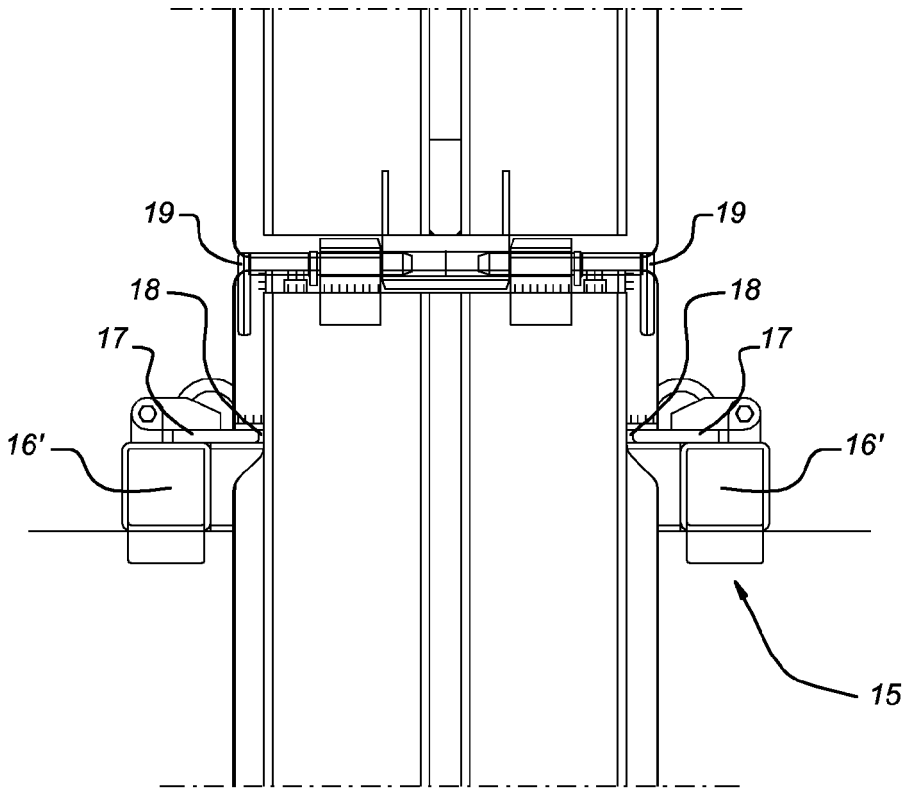


Fig 7

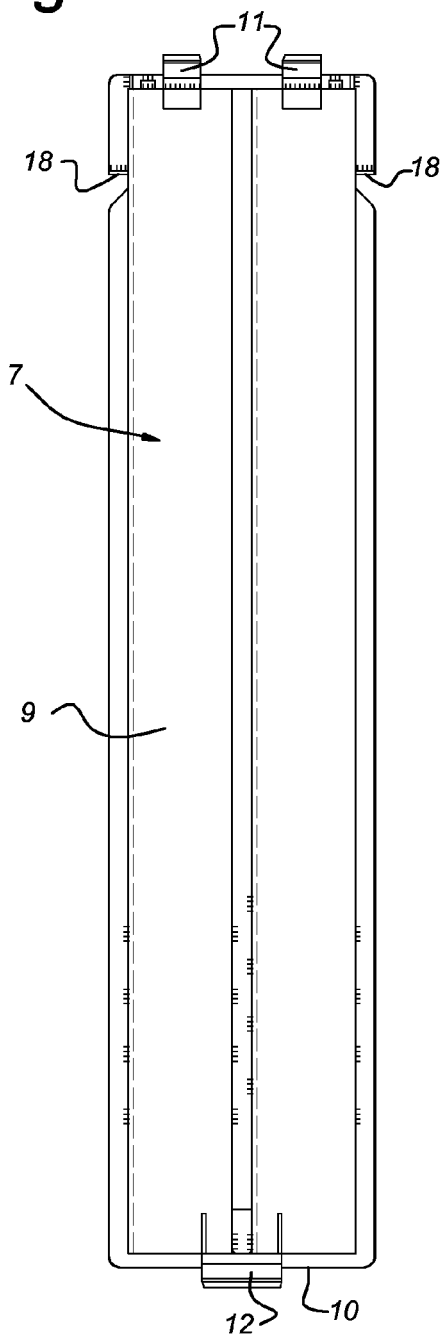


Fig 8

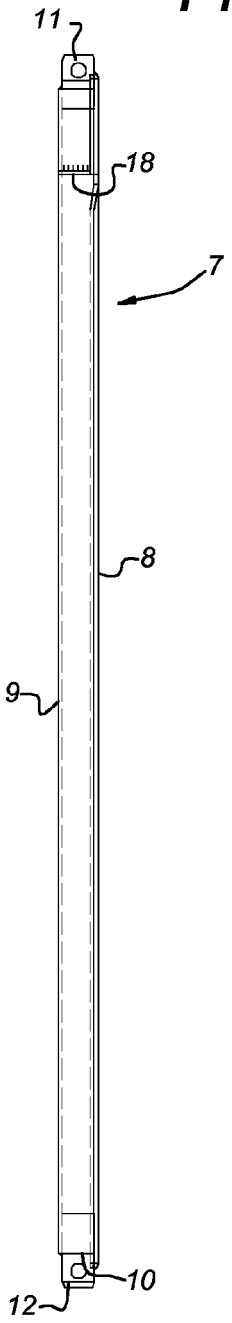


Fig 9

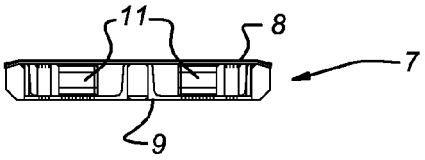


Fig 10

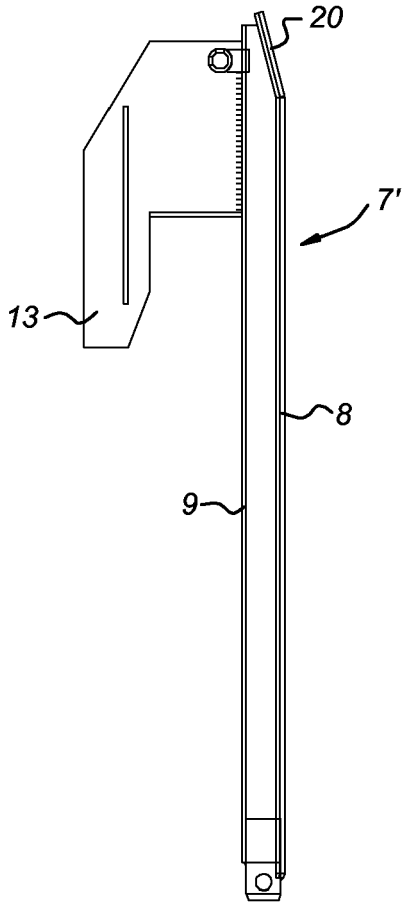
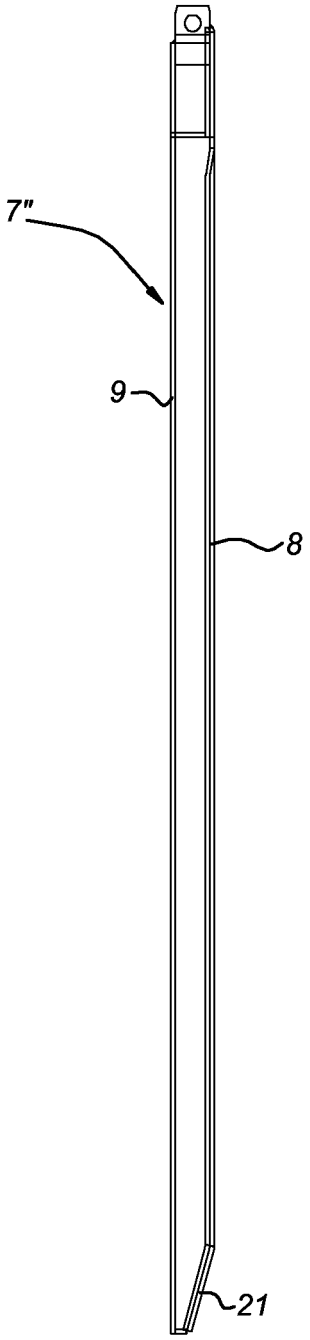


Fig 11



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EUROPEAN SEARCH REPORT

Application Number
EP 06 11 6647

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	GB 1 481 186 A (TERRESEARCH LTD) 27 July 1977 (1977-07-27) * page 1, line 91 - page 2, line 119; figures 1-4 *	1,2, 5-12, 17-20, 22, 24-26,33	INV. E02D5/18 E02D5/68
X	FR 2 145 756 A (SIF ENTR BACHY) 23 February 1973 (1973-02-23) * page 2, line 37 - page 5, line 1; figures 1-3 *	18,20, 21,24	
X	US 4 453 861 A (BRETZ ET AL) 12 June 1984 (1984-06-12) * column 3, line 31 - column 5, line 25; figures 1-6 *	18	
X	PATENT ABSTRACTS OF JAPAN vol. 018, no. 098 (M-1562), 17 February 1994 (1994-02-17) & JP 05 302325 A (NIPPON STEEL CORP; others: 02), 16 November 1993 (1993-11-16) * abstract *	33	

TECHNICAL FIELDS SEARCHED (IPC)

E02D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	29 September 2006	Leroux, Corentine

CATEGORY OF CITED DOCUMENTS

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 06 11 6647

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29-09-2006

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
GB 1481186 A	27-07-1977	NONE	
FR 2145756 A	23-02-1973	NONE	
US 4453861 A	12-06-1984	DE 2944385 A1	14-05-1981
JP 05302325 A	16-11-1993	NONE	

EPO FORM P0459

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