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### (54) METHOD FOR BUILDING A STRUCTURE IN THE GROUND

KONSTRUKTIONSVERFAHREN EINES UNTERIRDISCHEN BAUWERKES

PROCEDE POUR ERIGER UNE STRUCTURE DANS LE SOL

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## Description

The invention relates to a method as designated in the preamble of claim 1.

Such a method is known from "Civiele en Bouwkundige Techniek", no.8, September 1983, pages 21-24. Herein the foil is arranged in a construction space, the sides of which are bounded by ground with a natural slope. This requires much space which is permanently removed from the area surrounding the structure. This moreover requires much earthwork. In addition, the surface enclosed by the foil collects much rainwater which has to be pumped away.

The invention has for its object to reduce at least partly the drawbacks of the said known method.

The method according to the invention has for this purpose the characteristic of claim 1.

The invention also relates to and provides a structure built with use of the invented method. If the steel profiles are removed from the ground after arranging of the foil (14) the costs of this method are reduced considerably.

Mentioned and other features of the invention will be elucidated in the description of the invention following hereinbelow with reference to drawings, in which:

Figure 1 shows a top view of a structure during application of the method according to the invention; Figures 2-12 show on a larger scale the sections II-II to XII-XII indicated in figure 1; Figure 13 shows the section XIII-XIII of figure 1; Figures 14 and 16 show on a larger scale a top view of fraction XIV in figure 1 with two different embodiments; Figure 15 shows the section XV-XV of figure 14; Figure 17 shows a vertical section along the line XVII-XVII in figure 16; Figures 18-20 show sections corresponding with figures 6-8 relating to another embodiment variant of the method according to the invention; and Figure 21 shows on a larger scale detail XXI of figure 18.

In order to build a structure 1 according to the invention, which is drawn as example in completed state in figure 12 with dimensions in millimetres and which comprises carriageways 2 for road traffic located below ground level (MV), the method according to the invention is applied as shown schematically in successive steps in figures 1-11 and 13.

Figure 2: Steel sheet piling profiles 3 are struck into the ground to form sheet-pile walls 4 to enclose a construction excavation area 5.

Figure 3: The sheet-pile walls 4 are anchored in transverse direction by means of grouted anchors 6 or by means of cross struts 7 indicated with dashed lines.

The ground is excavated from the construction excavation area 5 to a level 8 lower than the floor level 9

of the carriageways 2 and higher than the bottom edge 10 of the sheet-pile walls 4. The excavation level 8 is a thickness of the sand layer 13 deeper than the laying level of the foil 14. The laying level of foil 14 is such that the water pressure under foil 14 is smaller than the total pressure of water and ballast material which is present above the foil 14 for arranging.

Figure 4: Support shields 11 are placed which are lined on their inner sides with a drainage layer 99.

Figure 5: In the channels 18 between sheet-pile walls 4 and support shields 11 are arranged water-inhibiting layers 12 and in addition a sand layer 13 of classified sand, without sharp portions, is arranged above the level 8.

Figure 6: A long watertight foil 14 is laid on the sand layer 13, wherein its side pieces 15 are folded over. The spreading out flat of foil 14 takes place for instance by means of sinking under its own weight in combination with cables 16 which are already pre-arranged through the support shield 11 (see figure 5). The side pieces 15 are erected against support shields 11 by means of cables 17 or optionally in that the ends of cables 16 are first moved to the edges 98 which are then pulled outward in horizontal direction by cables 16 and in that the edges 98 are thereafter pulled upward by means of cables 17.

Figure 7: Ground is arranged evenly up to floor level 9 inside the foil 14 and in the channels 18, preferably such that the ground level inside the foil is continually slightly higher than in the channels 18, wherein the necessary drainage pipes 20 are incorporated in this ground. Classified sand is herein arranged against foil 14.

Figure 8: The space inside foil 14 above the drainage pipes 20 is pumped dry. Draining takes place simultaneously in the channels 18 by means of drainage pipes 90. The water level in channels 18 is always kept slightly lower than the water level inside foil 14. In the space between foil 14 and support shield 11 the water level is likewise kept lower than the water level inside foil 14, this making use of the drainage mat 99 and provisions (not drawn) in the support shield 11. Supporting ground is arranged above floor level 9 as a natural slope or, preferably, supported by means of concrete retaining walls 22.

Figure 9: The sheet-pile wall profiles 3 can be pulled out of the ground and be re-used.

The structure 1 is then finished by laying of the carriageways 2 and sewage pipes 23.

In the method according to the invention the structure 1 is built, if it is long, in a number of construction excavations 25 which are located in succession and which are for instance 200 m long and mutually separated by means of partitions 26 (figures 10, 11, 14, 15). At the position of a partition 26 a connecting excavation area 27 is created between sheet-pile walls 4 by driving in sheet-pile wall profiles 33 to form transverse walls 34. This connecting excavation area 27 is divided into two

spaces 29 by driving in sheet-pile wall profiles 35 to form an intermediate wall 36.

After the ground has been excavated in the connecting excavation area 27 to a depth which is a concrete layer thickness deeper than the level 8, a concrete floor 32 is laid. After curing thereof this space 26 is pumped dry. A sill 31 and a standing wall 30 of reinforced concrete are arranged on floor 32 on either side of the sheet-pile wall 35. One of the sheet-pile walls 33 bounding a construction excavation area 5 which is in the situation of figure 5 is thereafter erected after the space 29 of the connecting excavation area 27 has been filled with water. The edge of the foil 14 arranged in construction excavation 25 is then fixed under water to the sill 31 and the wall 30 by divers by means of strips 38 and bolts 39. When both construction excavation areas 25 are provided on either side of the partition 26 with a continuous foil 14, or at a later stage, the wall 35 is also removed, wherein it is cut loose on the inner side and above the concrete.

Instead of a connecting excavation area 27 a partition 26 can be realized by means of the removable door 40 of figures 16 and 17. In each sheet-pile wall 4 a special U-shaped sheet-pile wall profile 41 is then employed in which a U-shaped coupling profile 42 is received slidably which is provided with flanges 43 for coupling on an edge of a foil 14 by means of strips 44 and bolts 45. A door 40 is arranged in the coupling profile 42 slidably and sealed by means of sealing strips 46.

The door 40 is slid downward in two sheet-pile wall profiles 41, while being held in place on the two coupling profiles 42 and on a coupling profile 48 which is situated on the bottom edge of the door 40, until this coupling profile 48 comes to support on sand layer 13. When both foils 14 are fixed to coupling profiles 42 and 48 the door 40 can be pulled up therefrom.

In the method of figures 18-21 a support shield 11 is not used but the side pieces 15 of foil 14 are held in place in a different way. For this purpose the folded edge 50 is drawn tighter by means of cables 51 which run through tubes 52 which are fixed to the sheet-pile wall 4, while the top edges 53 of the side pieces 15 are erected by means of cables 17 and thereafter held fixedly on means 55 present above the ground.

Once the structure 1 is completed the sheet-pile wall 4 can be removed and only the cables 51 remain behind in the ground.

It is conceivable to place the support shields 11 flat against the inner side of the sheet-pile walls 4, for instance in the form of plates which themselves have practically no bending stiffness but which support against the sheet-pile walls 4. During withdrawal of the sheet-pile walls 4 these support shields 11 are held in the ground.

The created structure 1 can contain a carriageway for road or rail vehicles, can also contain a storage space for separating the stored material from ground-water.

## Claims

1. Method for building in the ground a structure (1) with a floor (2) located at a floor level (9) under ground level, wherein in at least one construction excavation area (5) ground is excavated to a level that is lower than the floor level (9), wherein after excavation of the ground a construction space is closed off inside the construction excavation area (5) with a watertight foil (14), for instance of plastic, and wherein drainage provisions (20) are arranged under the floor level (9), **characterized by** the following steps:

the construction excavation area (5) is closed off with at least one construction excavation wall (4) of steel profiles (3) forming sheet-pile walls (4);

the ground is excavated from the construction excavation area (5) to a level (8) lower than the floor level (9) of the carriageways (2) and higher than the bottom edge (10) of the sheet-pile walls (4);

support shields (11) are placed;

in the channels (18) between sheet-pile walls (4) and support shields (11) are arranged water-inhibiting layers (12);

a watertight foil (14) is laid in the space between said support shields (11), wherein its side pieces (15) are erected against said support shields (11) such that the construction excavation area forms a pan which is sealed off by said foil (14); ground is arranged up to floor level (9) inside the foil (14) and in said channels (18), wherein the necessary drainage pipes (20) are incorporated in this ground; and

the space inside foil (14) above the drainage pipes (20) is pumped dry.

2. Method as claimed in claim 1, **characterized in that** the steel profiles (3) are removed from the ground after arranging of the foil (14).
3. Method as claimed in claim 1 or 2, **characterized in that** in at least a part of the construction excavation area (5) filler material, for example sand, is arranged simultaneously on either side of at least one erected foil wall (15).
4. Method as claimed in any of the foregoing claims, **characterized in that** at least one channel space (18) between the construction excavation wall (4) and an erected foil wall (15) is closed on its underside with water-inhibiting means, for instance a clay layer (12) or a foil strip.
5. Method as claimed in any of the foregoing claims, **characterized in that** at least one foil support

shield (11) is arranged inside the construction excavation area (5).

6. Method as claimed in claim 5, **characterized in that** at least a part of the foil support shield (11) is removed from the construction excavation area (5) after arranging of the foil (14). 5
7. Method as claimed in any of the foregoing claims, **characterized in that** at a location between at least two construction excavation areas (5) placed one after another is created at least one connecting excavation area (27) which is closed off by means of at least one construction excavation wall (34), wherein in the connecting excavation area (27) ground is excavated and a coupling construction (30-32) is arranged and wherein the end of at least one foil (14) is fixed to the coupling construction (30-32), but in preference ends of at least two foils (14) extending on either side of the coupling construction are fixed to the coupling construction (30-32). 10 15 20
8. Method as claimed in any of the claims 1-6, **characterized in that** construction excavation areas (5) are mutually separated by means of a door (40). 25
9. Structure manufactured with use of the method as claimed in any of the foregoing claims. 30

#### Patentansprüche

1. Verfahren zum Bauen eines Bauwerkes (1) in der Erde mit einem an einem Bodenniveau (9) unterhalb der ebenen Erde angeordneten Boden (2), bei dem in mindestens einem Aufbausgrabungsgebiet (5) die Erde auf ein Niveau ausgegraben wird, das tiefer als das Bodenniveau (9) ist, bei dem nach dem Ausgraben der Erde ein Aufbausraum in dem Aufbausgrabungsgebiet (5) mit einer wasserdichten Folie (14) zum Beispiel aus Kunststoff abgeschlossen wird und bei dem Abflußvorkehrungen (20) unter dem Bodenniveau (9) angeordnet werden, gekennzeichnet durch die folgenden Schritte: 35 40 45

das Aufbausgrabungsgebiet (5) wird mit mindestens einer Aufbausgrabungswand (4) aus Stahlprofile (3), die eine Spundwand (4) bilden, abgeschlossen; 50  
die Erde wird aus dem Aufbausgrabungsgebiet (5) bis zu einem Niveau (8) tiefer als das Bodenniveau (9) der Fahrbahnen (2) und höher als die Bodenkante (10) der Spundwände (4) ausgegraben; 55  
Stützschilder (11) werden plaziert;  
in den Kanälen (18) zwischen den Spundwän-

den (4) und den Stützschildern (11) werden Wasserverhinderungsschichten (12) angeordnet;

eine wasserdichte Folie (14) wird in den Raum zwischen den Stützschildern (11) gelegt, wobei ihre Seitenstücke (15) derart gegen die Stützschilder (11) aufgerichtet werden, daß das Aufbausgrabungsgebiet eine Pfanne bildet, die durch die Folie (14) abgedichtet ist; Erde wird bis zu dem Bodenniveau (9) innerhalb der Folie (14) und in den Kanälen (18) angeordnet, wobei notwendige Abflußrohre (20) in diese Erde eingesetzt werden; und der Raum innerhalb der Folie oberhalb der Abflußrohre (20) wird trockengepumpt.

2. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß die Stahlprofile (3) aus der Erde nach dem Anordnen der Folie (14) entfernt werden.
3. Verfahren nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß mindestens ein Teil des Füllmaterials des Aufbausgrabungsgebietes (5), zum Beispiel Sand gleichzeitig auf beiden Seiten von mindestens einer aufgerichteten Folienwand (15) angeordnet wird.
4. Verfahren nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß mindestens einer der Kanäle (18) zwischen der Aufbausgrabungswand (4) und einer aufgerichteten Folienwand (15) an seiner Unterseite mit einem Wasserverhinderungsmittel, zum Beispiel einer Tonschicht (12) oder einem Folienstreifen geschlossen wird.
5. Verfahren nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß mindestens ein Folienstützschild (11) innerhalb des Aufbausgrabungsgebietes (5) angeordnet wird.
6. Verfahren nach Anspruch 5, dadurch gekennzeichnet, daß mindestens ein Teil des Folienstützschildes (11) aus dem Aufbausgrabungsgebiet (5) nach Anordnen der Folie (14) entfernt wird.
7. Verfahren nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß einer Stelle zwischen mindestens zwei Aufbausgrabungsgebieten (5), die eines nach dem anderen angeordnet sind, mindestens ein verbindendes Ausgrabungsgebiet (27) erzeugt wird, das mittels mindestens einer Aufbausgrabungswand (34) abgeschlossen wird, wobei in dem verbindenden Ausgrabungsgebiet (27) Erde ausgegraben wird und ein Verbindungsaufbau (30-32) angeordnet wird und wobei das Ende von mindestens einer Folie (14) an dem Verbindungsaufbau (30-32) befestigt wird, aber bevorzugt werden Enden von mindestens zwei Folien

(14), die sich auf beiden Seiten des Verbindungsaufbaues erstrecken, an dem Verbindungsaufbau (30-32) befestigt.

8. Verfahren nach einem der Ansprüche 1 bis 6, dadurch gekennzeichnet, daß die Aufbaugrabbauungsgebiete (5) voneinander mittels einer Tür (40) getrennt werden.
9. Bauwerk, das unter Benutzung des Verfahrens hergestellt ist, wie es in einem der vorhergehenden Ansprüche beansprucht wird.

## Revendications

1. Procédé permettant d'ériger, dans le sol, une structure (1) comportant un plancher (2) situé à un niveau de plancher (9) sous le niveau du sol, dans lequel, dans au moins une zone d'excavation de travail (5), du terrain est excavé jusqu'à un niveau qui est inférieur au niveau de plancher (9), un espace de travail étant, après l'excavation du terrain, obturé à l'intérieur de la zone d'excavation de travail (5) avec une feuille étanche à l'eau (14), par exemple en plastique, et des dispositifs de drainage (20) étant installés sous le niveau de plancher (9), caractérisé par les étapes suivantes :

la zone d'excavation de travail (5) est fermée avec au moins un mur d'excavation de travail (4) constitué de profilés en acier (3) formant des murs de palplanche (4) ;

le terrain est excavé de la zone d'excavation de travail (5), jusqu'à un niveau (8) inférieur au niveau de plancher (9) des chaussées (2) et supérieur au bord inférieur (10) des murs de palplanche (4) ;

des boucliers de support (11) sont mis en place ;

des couches (12) arrêtant l'eau sont disposées dans les canaux (18), entre les murs de palplanche (4) et les boucliers de support (11) ;

une feuille étanche à l'eau (14) est posée dans l'espace situé entre lesdits boucliers de support (11), ses parties latérales (15) étant dressées contre lesdits boucliers de support (11), de telle sorte que la zone d'excavation de travail forme un bac rendu étanche par ladite feuille (14) ;

du terrain est remblayé jusqu'au niveau de plancher (9) à l'intérieur de la feuille (14) et dans lesdits canaux (18), les tuyaux de drainage nécessaires (20) étant incorporés dans ce terrain ; et

l'espace qui se trouve à l'intérieur de la feuille (14), au dessus des tuyaux de drainage (20) est asséché par pompage.

2. Procédé selon la revendication 1, caractérisé en ce que les profilés en acier (3) sont retirés du terrain après la mise en place de la feuille (14).

3. Procédé selon la revendication 1 ou 2, caractérisé en ce que, dans au moins une partie de la zone d'excavation de travail (5), un matériau de remplissage, par exemple du sable, est disposé simultanément de l'un et l'autre côté d'au moins une paroi (15) constituée d'une feuille redressée.

4. Procédé selon l'une quelconque des revendications précédentes, caractérisé en ce qu'au moins un espace de canal (18), entre la paroi d'excavation de travail (4) et une paroi (15) constituée d'une feuille redressée, est fermé sur son côté inférieur à l'aide d'un moyen arrêtant l'eau, par exemple une couche d'argile (12) ou une feuille en bande.

5. Procédé selon l'une quelconque des revendications précédentes, caractérisé en ce qu'au moins un bouclier de support de feuille (11) est disposé à l'intérieur de la zone d'excavation de travail (5).

6. Procédé selon la revendication 5, caractérisé en ce qu'au moins une partie du bouclier de support de feuille (11) est retirée de la zone d'excavation de travail (5), après la mise en place de la feuille (14).

7. Procédé selon l'une quelconque des revendications précédentes, caractérisé en ce que, en un point situé entre au moins deux zones d'excavation de travail (5) placées l'une après l'autre, est créée au moins une zone d'excavation de liaison (27) qui est obturée au moyen d'au moins un mur d'excavation de travail (34), du terrain étant excavé de la zone d'excavation de liaison (27) et une structure d'accouplement (30-32) étant disposée dans cette dernière, et où l'extrémité d'au moins une feuille (14) est fixée à la structure d'accouplement (30-32), mais de préférence les extrémités d'au moins deux feuilles (14) s'étendant sur l'un et l'autre côté de la structure d'accouplement sont fixées à la structure d'accouplement (30-32).

8. Procédé selon l'une quelconque des revendications 1 à 6, caractérisé en ce que les zones d'excavation de travail (5) sont séparées l'une de l'autre par une porte (40).

9. Structure fabriquée à l'aide du procédé selon l'une quelconque des revendications précédentes.

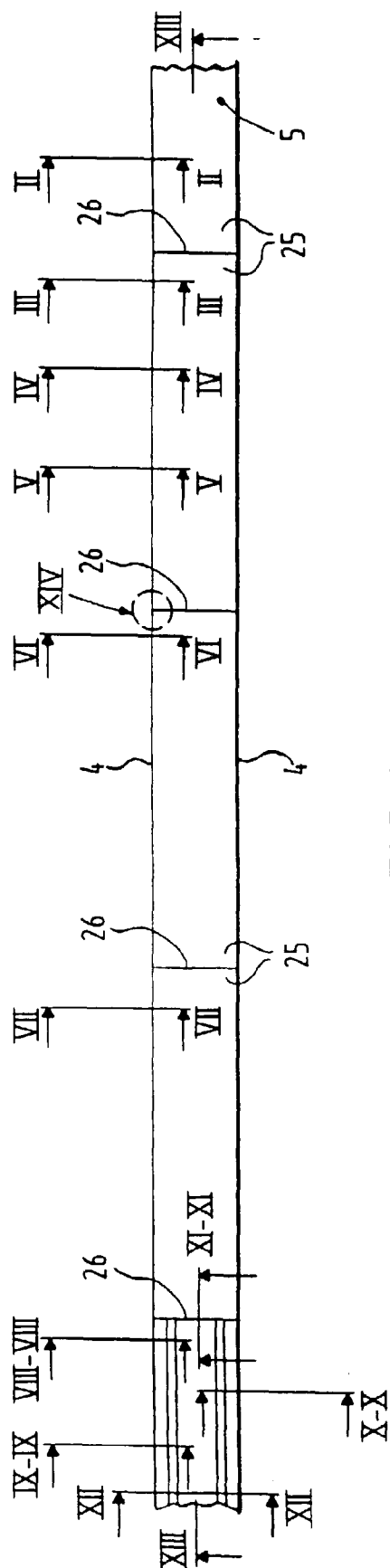
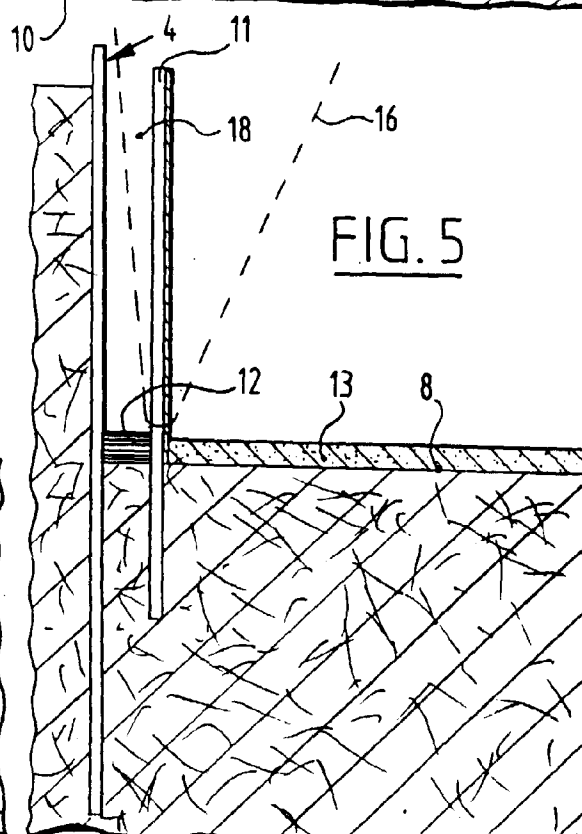
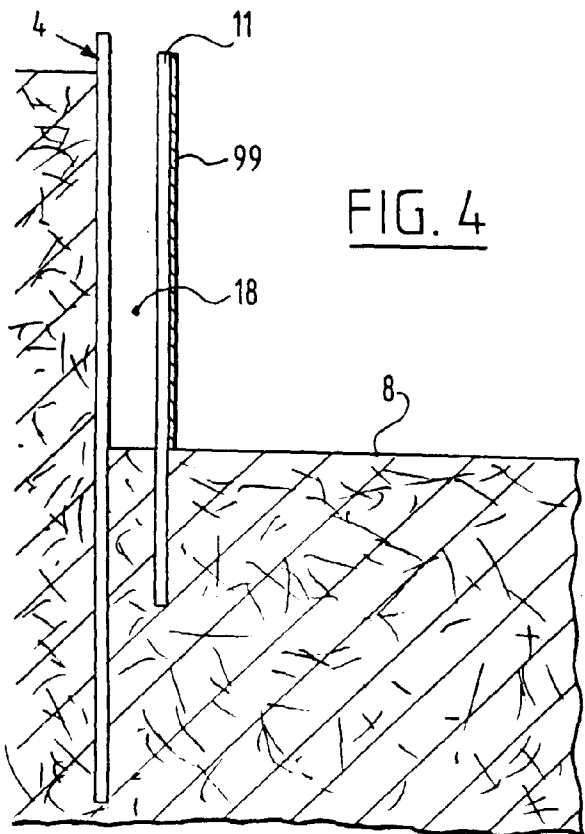
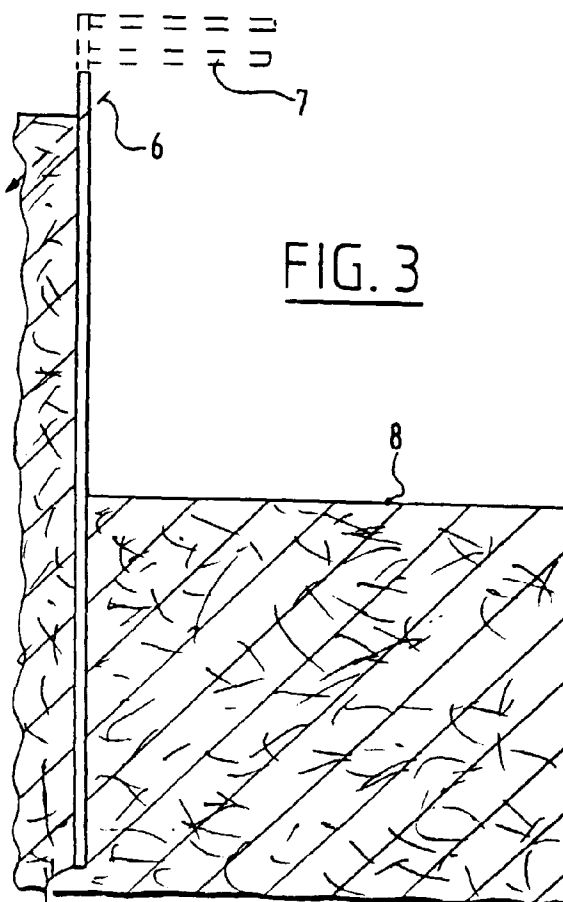
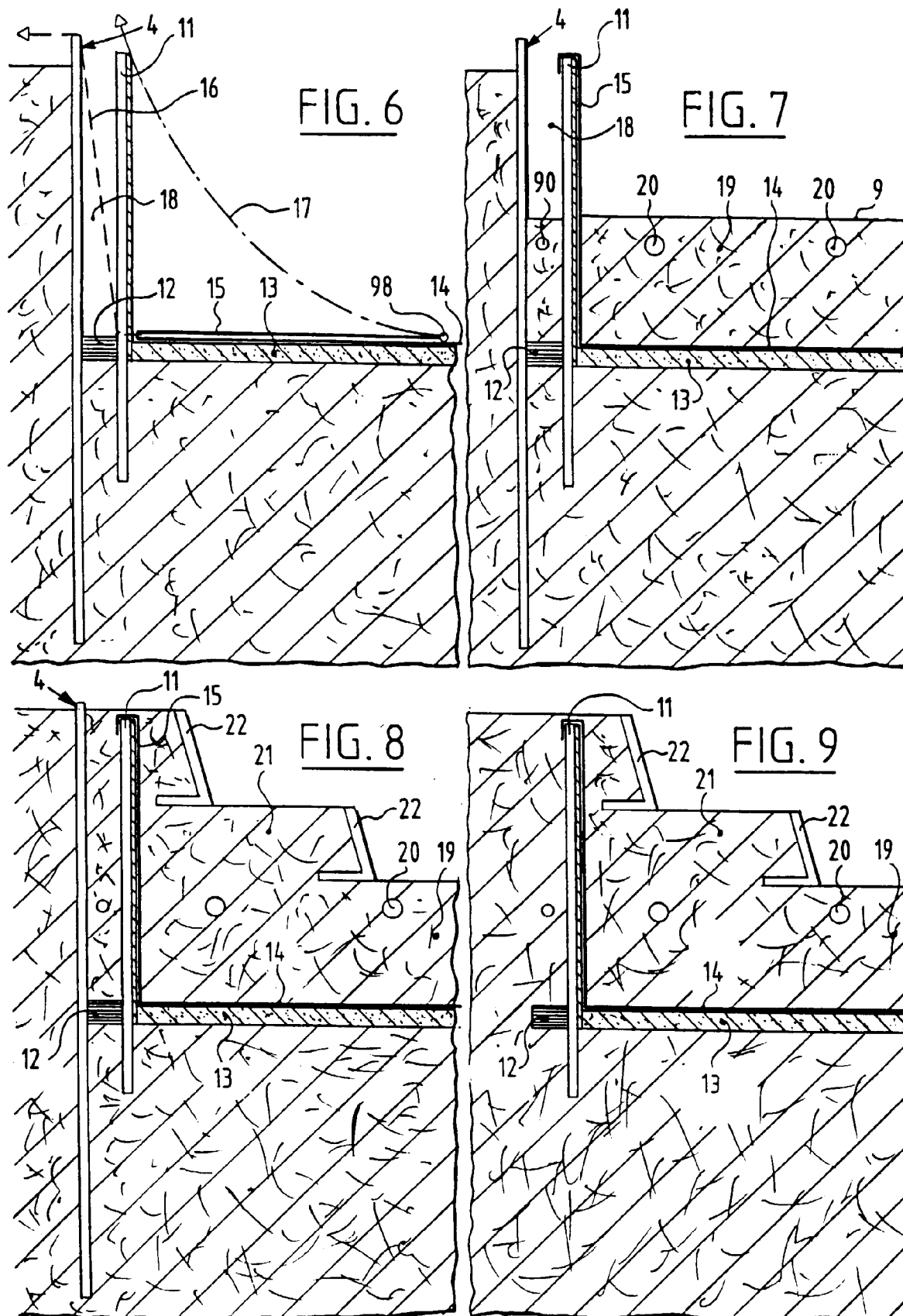


FIG. 1

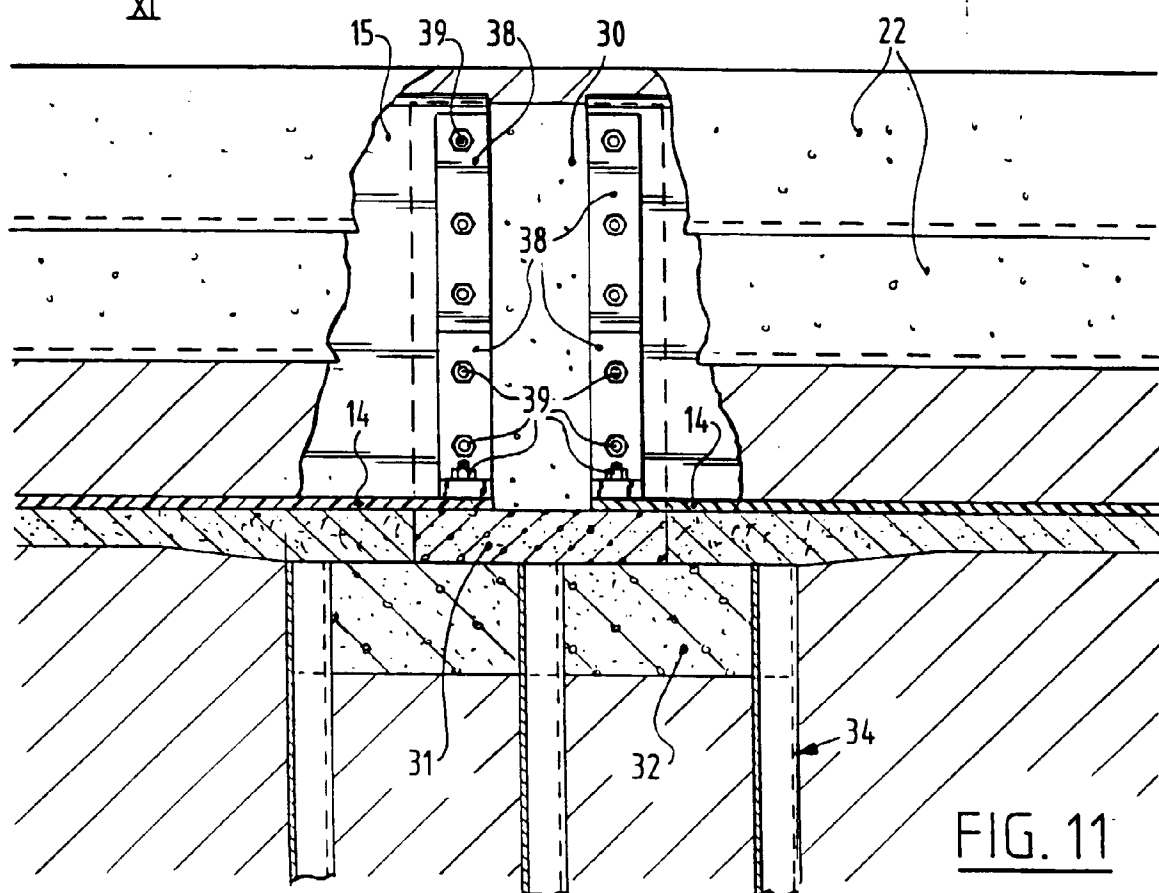
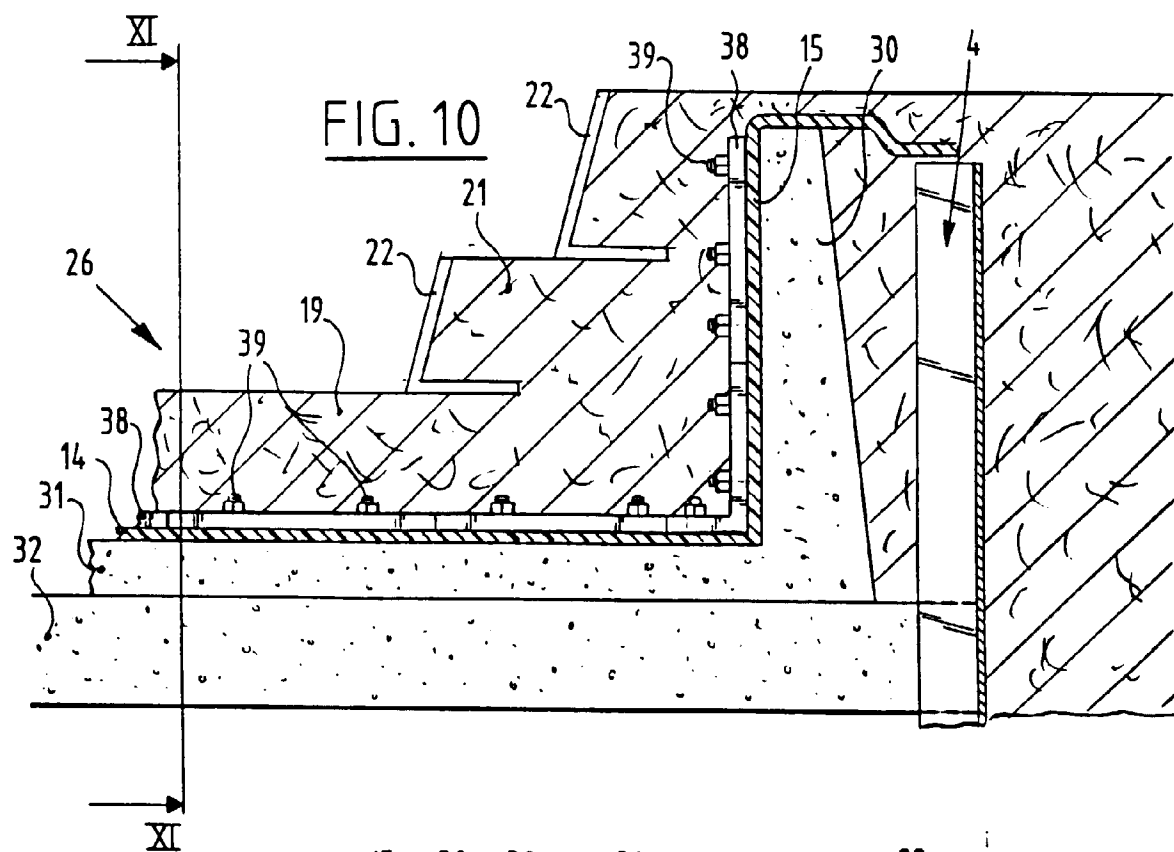


FIG. 13









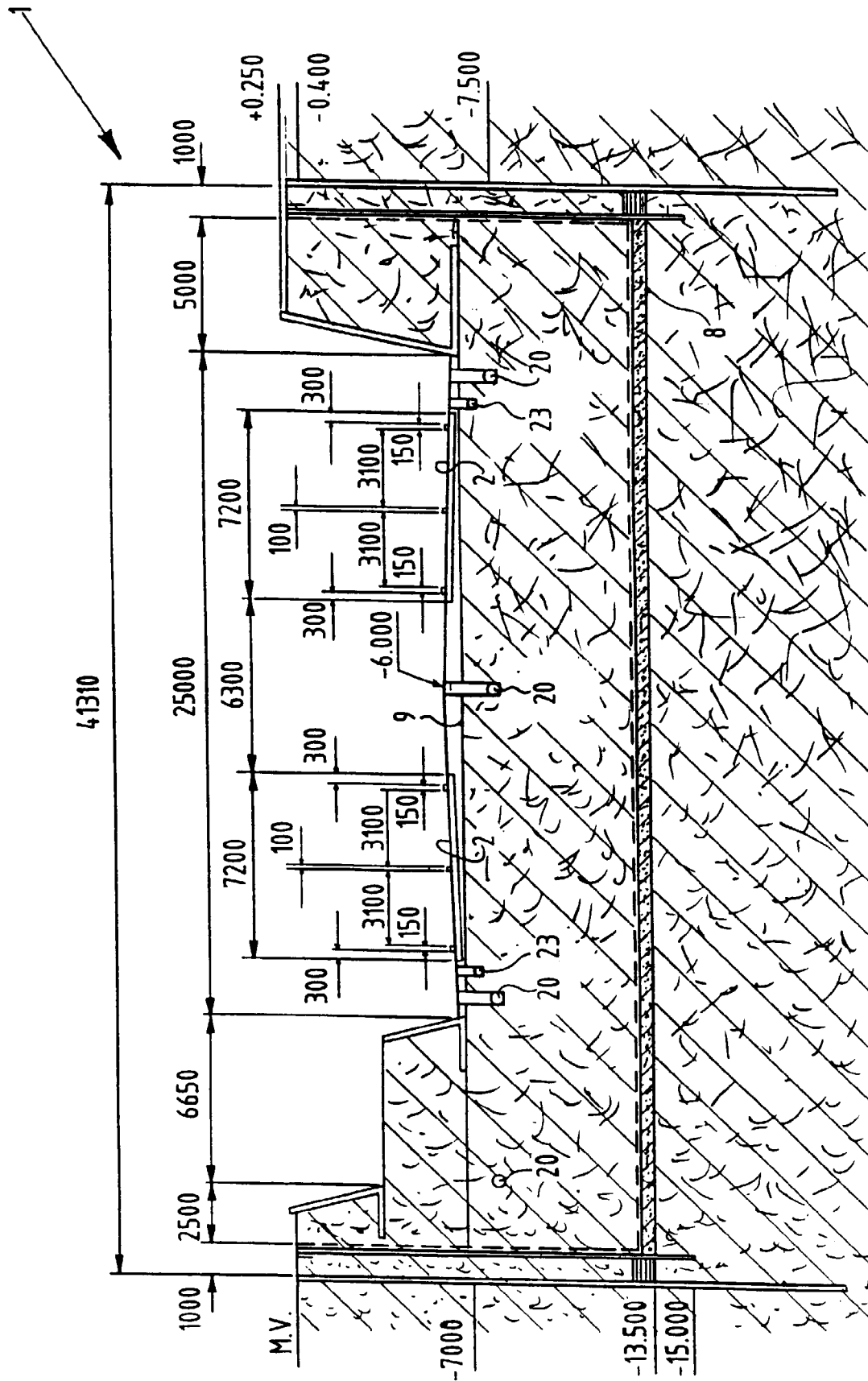


FIG.12

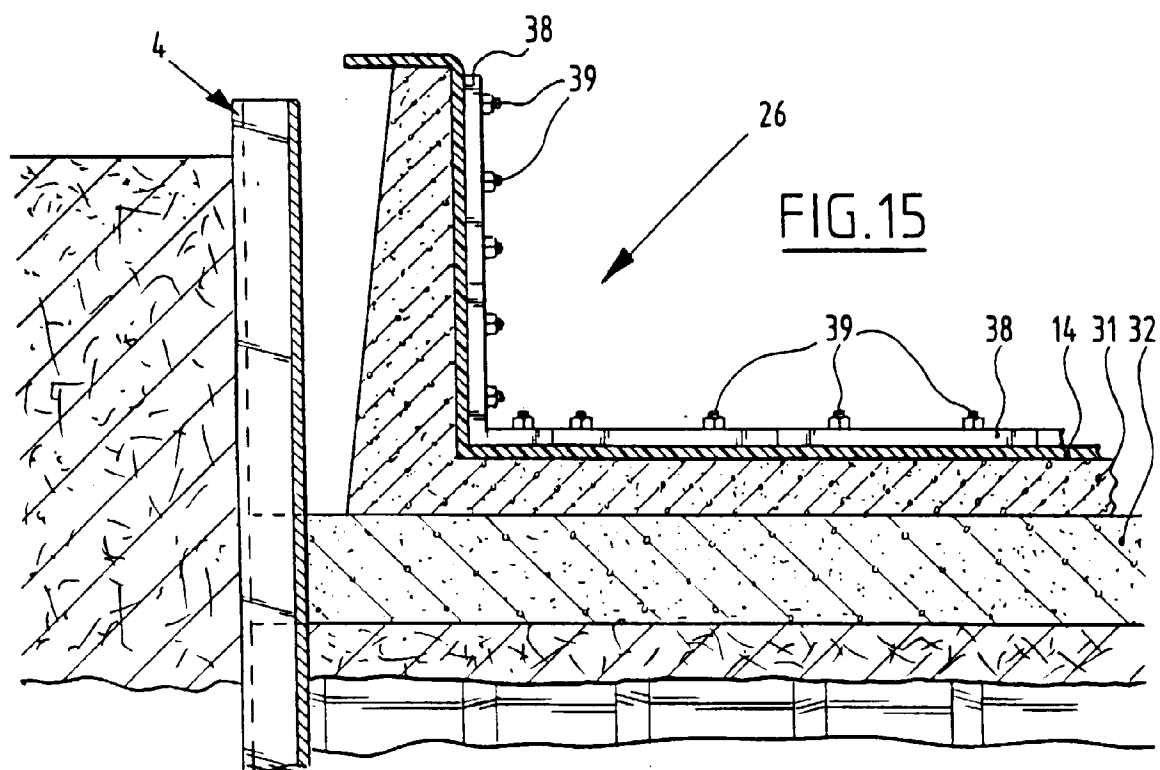
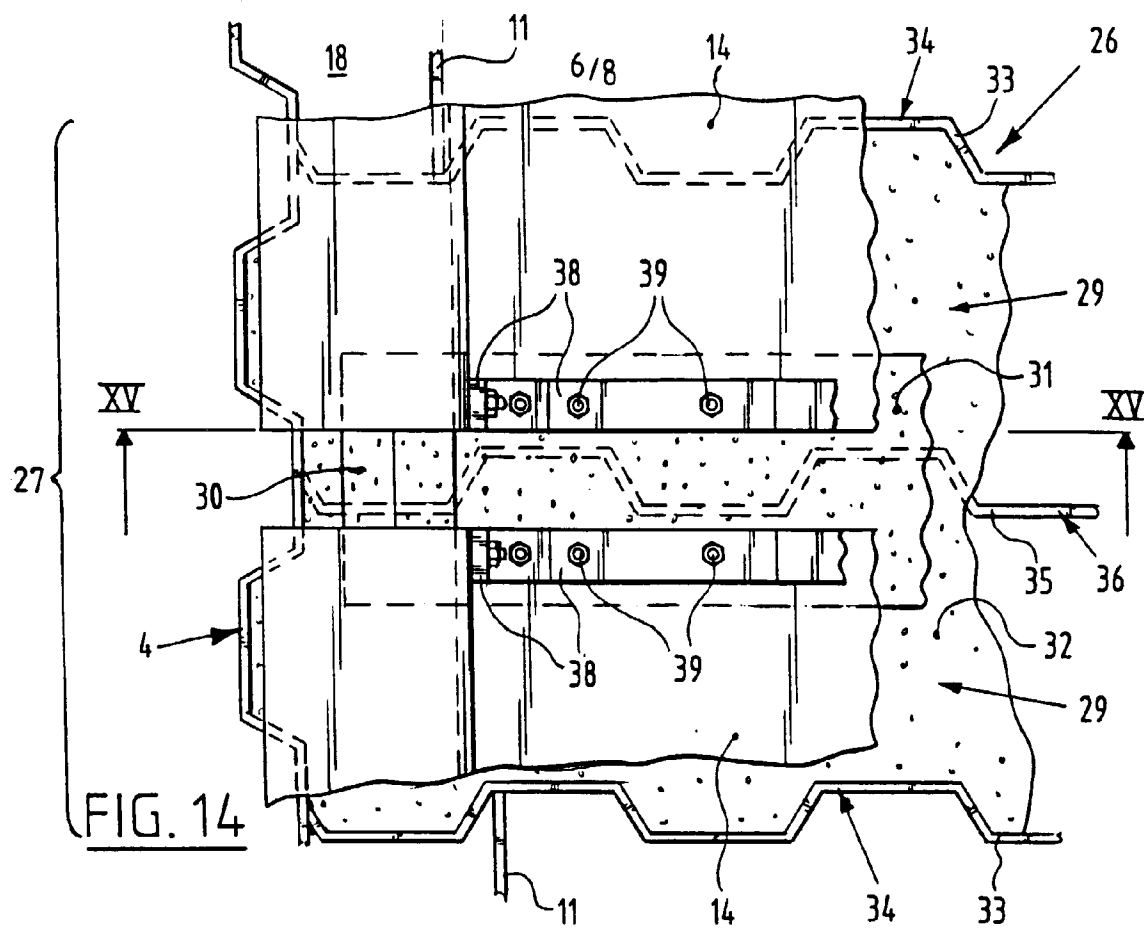


FIG. 16

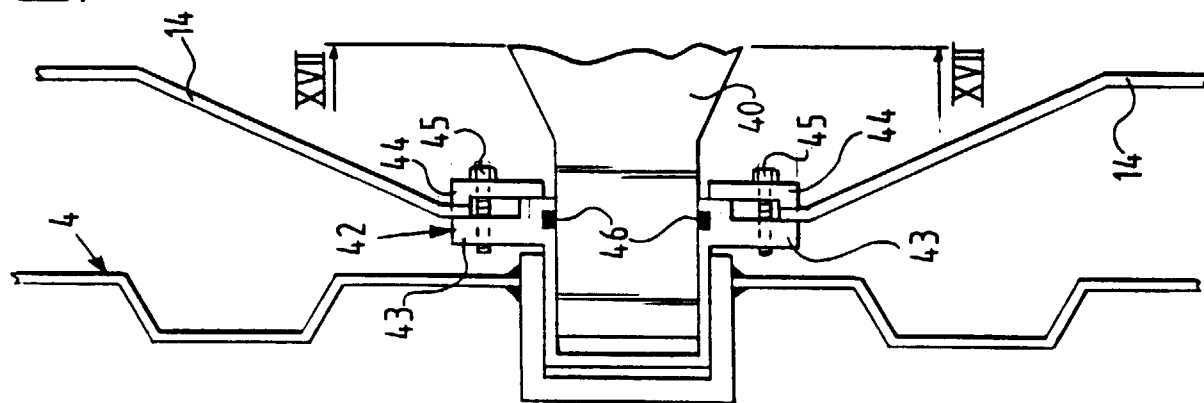


FIG. 17

