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(11) Publication number: **0 444 727 B1**

(12)

EUROPEAN PATENT SPECIFICATION

(49) Date of publication of patent specification: **17.05.95** (51) Int. Cl.⁶: **E02D 5/04**, E02D 5/74

(21) Application number: **91200163.3**

(22) Date of filing: **28.01.91**

The file contains technical information submitted
after the application was filed and not included in
this specification

(54) **A method of making sheet piling, and section sheet pile for use in said method.**

(30) Priority: **29.01.90 NL 9000212**

(43) Date of publication of application:
04.09.91 Bulletin 91/36

(45) Publication of the grant of the patent:
17.05.95 Bulletin 95/20

(84) Designated Contracting States:
BE DE FR LU NL

(56) References cited:
DE-C- 611 277
LU-A- 83 420
NL-C- 23 170

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Description

The invention relates to a method of making sheet piling as defined in the preamble of claim 1, in which the features are generally known from the prior art, and to an Ω -section sheet pile for use in the method.

It is well known to make sheet piling from sheet piles of Z-shaped pile section, i.e. a pile made from steel through hot rolling or cold shaping, having a cross-sectional shape which is composed of two parallel end flanges joined by an inclined intermediate portion, the two flanges having a hook at their free end.

For a long time now, planking, landing stages, wharves and similar bank provisions along waterways have been composed of separate driven hot-rolled steel sheet piles, which are joined to each other by means of interlocking hooks extending along their edges (forming the so-called lock).

For a retaining wall to be formed, such piles are driven or vibrated into the ground successively or in groups, with adjoining sheet piles interlocking through the hooks extending throughout the length of the free edges. The sectional profile of the finished retaining wall is determined by the profile of the piles that are used and by the relative position of the successive piles, which depends on whether the piles are all driven in in the same position or whether each successive pile is rotated through 180° about its longitudinal axis relative to the preceding pile. In general, a retaining wall has a crenellated cross-section, the C-shaped hollow sides being referred to as channels.

Further, when the height of retaining walls that have thus been built up exceeds a certain value, they must be secured to the mass of earth bearing on them at the back by means of anchors. An anchor is a rod with a widened end, extending through a sheet pile into the ground behind the pile. The rod is connected at the front of the pile by means of an anchor seat, which is welded to the pile. There exist so-called grout anchors, in which the anchor rod is guided through a tube and its free end is arranged in a ball of mortar (grout).

By employing pile cross-sections of great height (deep channel) high moments of resistance and inertia are also obtained in the case of small wall thicknesses. The comparatively small amount of material required leads to more economic planking designs, wherein often cold-shaped sheet piles are used.

With respect to the choice of the shape of the sheet piles, the following can be observed.

Z-shaped pile sections, i.e. piles of a sectional form which is composed of two parallel end flanges which are joined by an inclining intermediate portion, are more eligible than U-shaped or Ω -shaped

pile sections as regards cost price.

U-section sheet piles have a trapezoidal section formed by an intermediate portion with two slightly diverging flanges whose free ends terminate directly in the locking hooks. In a retaining wall built up from such U-section piles, each successive pile has been rotated through 180° about its longitudinal axis relative to the preceding pile. In this arrangement, the locks in the retaining wall are in the "neutral line" and the theoretic moment of resistance is thereby reduced.

Ω -shaped pile sections, i.e. piles with a sectional form consisting of an intermediate portion, two diverging flanges with two end portions which extend parallel to the intermediate portion and terminate in locking hooks, have so little stiffness of their own in the case of small wall thickness, that they are hard to manipulate in the case of greater widths. It is therefore customary to compose Ω -shaped pile sections from Z-section piles by joining them in pairs and interconnecting them by spot welding, while each successive pile is rotated through 180° about its longitudinal axis relative to the preceding one. By starting thus from Z-sections, Ω -sheet piling of great widths of 130 cm can be obtained without the disadvantage of poor rigidity inherent to Ω -section piles.

An important disadvantage of Z-sections now used in this manner is that a lock extends in the middle of each channel in a retaining wall, which lock forms an obstruction when an anchor is being mounted. For the anchor seat to be in surface-to-surface contact with the bottom of the channel, either the lock must be burnt away locally or the bottom of the channel must be filled up locally on opposite sides of the inwardly projecting lock by means of filler plates to adjust to the thickness of the lock.

The drawback of burning away the lock before a sheet pile is driven in, is that the pile is weakened and will be deformed when it is being driven into heavier types of soil. Burning away the lock after a pile has been driven in is nearly always made more difficult by the presence of soil and/or ground water.

Mounting filler plates on opposite sides of the lock to form a flat support for the base plate of the anchor seat has the drawback, in addition to the fact that more material is required, that a great deal of additional high-quality welding must be performed under difficult conditions in order to effect a connection that is capable of transmitting great vertical shearing forces from the (grout) anchor and the anchor seat to the sheet piles that constitute the planking.

The problems outlined hereinabove are avoided in that in the method of making sheet piling made of interlocking Z-section sheet piles driven

into the ground and having a sectional form which is composed of two parallel end flanges joined by an inclined intermediate portion, the two flanges being provided with a hook at their free end, wherein each second one of said Z-section piles has been rotated through 180° about its longitudinal axis relative to the adjacent pile so as to form Ω -section piles interlocking through hooks extending throughout the lengths of their free edges, and wherein at least one of said Ω -section piles is provided with an anchor plate at the channel bottom thereof and on one side of the interlocking hooks for the purpose of positioning an anchor, according to the invention, the Ω -section sheet piles are made from pairs of previously welded together Z-section sheet piles having in a manner known-per-se the inclined intermediate portion thereof located between two parallel end flanges of different length, the anchor plate is located on the flange of the greatest length of a pile to be substantially centered on the axis (H-H) of the channel bottom (12) of the Ω -section sheet pile, and the Ω -section sheet piles are driven or vibrated into the ground successively or in groups.

In sheet piling realized in this manner, each channel contains enough space on the side of the lock extending therethrough, for an anchor seat to be mounted directly against the channel bottom. It only remains necessary that elliptical holes are burnt in the sheet piles in question for passing therethrough the anchor rod and a grout injection tube. This, too, may be done in a simpler manner than in sheet piling obtained in the conventional manner wherein the Ω -section sheet piles are made from symmetrically formed Z-piles because it is not necessary to burn through the lock extending in the middle of the channel.

In the present application of asymmetrical Z-section piles for making Ω -section sheet piles, the aforementioned disadvantages of retaining walls built up from the known symmetrical Z-section piles with regard to the anchorage of the wall, are avoided, while maintaining the advantages thereof, namely, the comparatively low cost-price and locks located off the neutral line in a retaining wall.

The invention also relates to an Ω -section sheet pile suitable for use in the method according to claim 1, said Ω -section sheet pile being composed of two interconnected Z-section piles each made from steel through hot rolling or cold formation and having a sectional form which is composed of two parallel end flanges of unequal length, joined by an inclined intermediate portion, the two flanges being provided with a hook at their free end, one of said Z-section piles in said Ω -section pile has been rotated through 180° about its longitudinal axis relative to the other pile, wherein the lock connecting said two Z-section piles is sufficiently displaced

laterally relative to the axis of the channel bottom to locate thereon an anchor plate substantially centered on said axis.

It is observed that in DE-C-611277 (Kurt Willner) an asymmetrical Z-section sheet pile is proposed, but with an entirely different aim than in the present invention, namely to reduce deviation of the free lock edge during the driving operation. The method according to the invention and the specific use of asymmetric Z-section sheet piling to enable better anchorage of the wall, cannot be derived from that publication. In the method described in that publication, for forming sheet piling, the Z-section piles are driven in one by one without prior joining to form Ω -sections.

It is further observed that in "Die Spundwand Hoesch", 5. verbesserte Auflage 1962, page 75, an Ω -type sheet piling is shown composed of Z-section piles, each second pile being rotated through 180° about its longitudinal axis and successive sheets being interlocked by their respective hooks. It is shown in the reference that in each of the Z-section sheets the inclined intermediate portion being located off the centre of said Z-section piles so that each of the so obtained Ω -section piles has end flanges of different lengths. It is also shown in the reference that each of the end flanges in a pile channel bottom is either bolted to a purlin or an anchor plate is located on the longer end flange on one side of a lock while the shorter end flange at the opposite side of the lock is bolted to the purlin.

In further explanation of the invention, with reference to the accompanying drawings, hereinafter will now be discussed one embodiment of sheet piling with asymmetric Z-section and the use thereof in the manufacture of sheet piling.

Fig. 1 is a diagrammatic top plan view of a part of a retaining wall which is built up from known symmetrical Z-section piles;

Fig. 2 is an elevational view according to Fig. 1, with U-section piles;

Fig. 3 is a similar view with Ω -section piles;

Fig. 4 is an elevational view according to Fig. 1, with Ω -section sheet piles according to the invention;

Fig. 5 is a front view of a detail of a retaining wall made from sheet piles according to the invention;

Fig. 6 is a top plan view of the retaining wall Fig. 5; and

Fig. 7 is an enlarged side elevational view taken on the line VII-VII of Fig. 5.

Referring to Figs. 1-4, a retaining wall is built up from piles 1 provided at the side edges with hooks 2,3 which interlock in the manner indicated to form a lock together for laterally coupling together the sheet piles. Each sheet pile 1 in principle comprises an intermediate portion 4 and two

flanges 5 and 6, adjoining thereto on opposite sides. In the Z- and U-section forms of Figs. 1, 2, and 4, the hooks are provided directly at the end edges of the flanges 5 and 6. In the Ω -section form of Fig. 3, adjoining to flanges 5 and 6 are end

portions 7 and 8 formed with hooks 2 and 3. In the retaining wall according to Fig. 2, successive piles 1 have been rotated through 180° about their longitudinal axis, relative to the preceding pile. In the wall according to Fig. 3, successive

piles are of the same orientation. The neutral line, i.e. the line which is subject neither to tensile load nor to pressure load in the case of bending load B on the retaining wall in the plane of the drawing (see Fig. 2) is indicated by N-N.

In Z-section piles it is customary first to join them in pairs in the manner indicated by local welding and to drive the channel sections (Ω -sections) obtained thus into the ground. Fig. 1 illustrates the problem that is the basis for the invention. When anchoring in the ground a retaining wall built up from symmetrical Z-sections 1 (which have first been welded together pairwise to form Ω -sections) by means of ground anchors 9, it is requisite that the base plate 10 of the anchor seat 11 can be welded against a flat part (the channel bottom 12) of a sheet pile. It is impossible for this plate 10 to be seated against the bottom of the channel 12 of the corresponding sheet piles, formed by the two flanges 6, because the lock 2/3 projects from the middle of the bottom 6+6. In order to provide a flat support surface, either the lock 2/3 must be burnt away locally or the space on opposite sides of the lock must be filled up by means of filler plates 13, which is cumbersome and expensive.

By forming, as shown in Fig. 4, the Z-section piles asymmetrically, with the inclined intermediate portion off the centre of the pile 1, i.e. the flanges 5 and 6 are of different lengths, the lock 2/3 will be located laterally of the axis H-H and, on the side of the lock there will be enough space on the channel bottom 12 for an anchor seat 11.

Figs. 5 and 6, respectively, show a front view and a top plan view of the anchorage of a retaining wall which is built up from asymmetrical piles 1 according to the invention and also show the conventional purlin 13, i.e. the transverse bracing. Fig. 6 further shows a grout ball 14.

Fig. 7 shows in more detail the connection of the anchor seat 11 to the bottom of a pile channel 12 and concentric tubes 15 through which extends the anchor rod 9.

Claims

1. A method of making sheet piling made of interlocking Z-section sheet piles (1) driven

into the ground and having a sectional form which is composed of two parallel end flanges (5,6) joined by an inclined intermediate portion (4), the two flanges being provided with a hook (2,3) at their free end, wherein each second one of said Z-section piles has been rotated through 180° about its longitudinal axis relative to the adjacent pile so as to form Ω -section piles interlocking through the hooks (2,3) extending throughout the lengths of their free edges, and wherein at least one of said Ω -section piles is provided with an anchor plate (10) at the channel bottom thereof and on one side of the interlocking hooks for the purpose of positioning an anchor (9), characterised in that the Ω -section sheet piles are made from pairs of previously welded together Z-section sheet piles having in a manner known-per-se the inclined intermediate portion (4) thereof located between two parallel end flanges (5,6) of different length, that the anchor plate (10) is located on the flange (6) of the greatest length of a pile to be substantially centered on the axis (H-H) of the channel bottom (12) of the Ω -section sheet pile, and that the Ω -section sheet piles are driven or vibrated into the ground successively or in groups.

2. An Ω -section sheet pile suitable for use in the method according to claim 1, said Ω -section sheet pile being composed of two interconnected Z-section piles (1) each made from steel through hot rolling or cold formation and having a sectional form which is composed of two parallel end flanges (5,6) of unequal length, joined by an inclined intermediate portion (4), the two flanges being provided with a hook (2,3) at their free end, one of said Z-section piles in said Ω -section pile has been rotated through 180° about its longitudinal axis relative to the other pile, wherein the lock (2/3) connecting said two Z-section piles (1) is sufficiently displaced laterally relative to the axis (H-H) of the channel bottom (12) to locate thereon an anchor plate (10) substantially centered on said axis (H-H).

Patentansprüche

1. Verfahren zur Herstellung einer Spundwand aus ineinandergreifenden Z-Profil-Blechpfählen (1), die in den Boden getrieben werden und eine Querschnittsgestalt haben, die aus zwei parallelen Endflanschen (5, 6) besteht, die ein schrägverlaufender Zwischenabschnitt (4) verbindet, wobei die zwei Flansche an ihrem freien Ende mit einem Haken (2, 3) versehen sind, bei dem jeder zweite Z-Profil-Pfahl relativ zu

nächstfolgenden Pfahl 180° um seine Längsachse gedreht wird, um mittels der sich über die gesamte Länge ihrer freien Kanten erstreckenden Haken (2, 3) ineinandergreifende U-Profil-Pfähle zu bilden, und mindestens einer der U-Profil-Pfähle an Profilboden und auf einer Seite der ineinandergreifenden Haken mit einer Ankerplatte (10) zum Setzen einer Ankerstange (9) versehen ist, **dadurch gekennzeichnet**, daß man die U-Profil-Pfähle aus Paaren zuvor verschweißter Z-Profil-Pfähle herstellt, deren geschrägter Zwischenabschnitt (4) auf bekannte Weise zwischen zwei parallelen Endflanschen (5, 6) unterschiedliche Länge liegt, daß man die Ankerplatte (10) auf dem Flansch (6) mit der größten Länge eines Pfahls so anordnet, daß sie im wesentlichen auf der Achse (H-H) des Profilbodens (12) des U-Profil-Pfahls zentriert liegt, und daß man die U-Profil-Pfähle nacheinander oder gruppenweise in den Boden einschlägt oder einrüttelt.

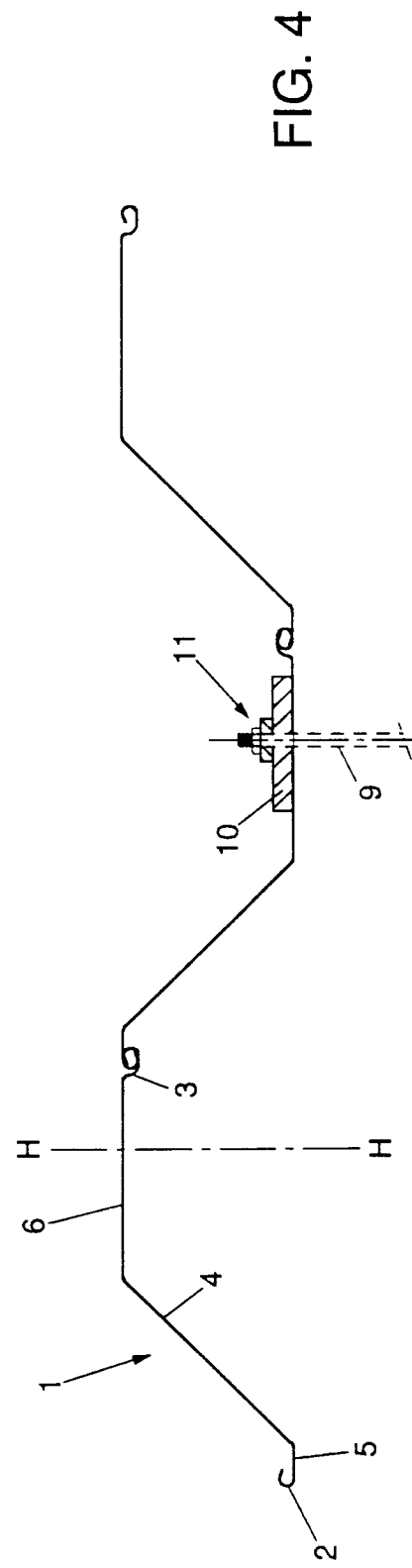
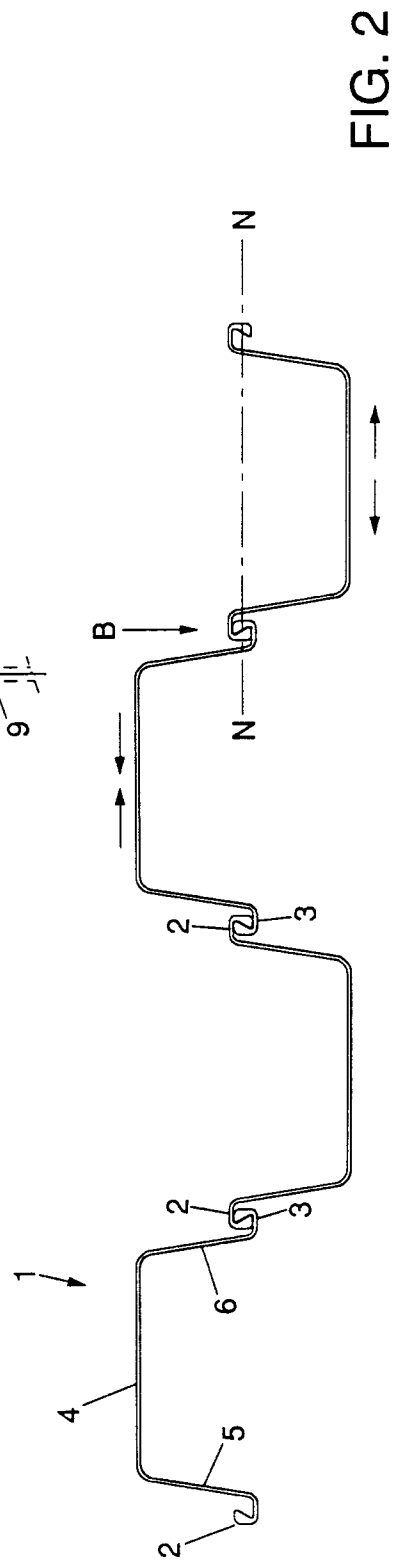
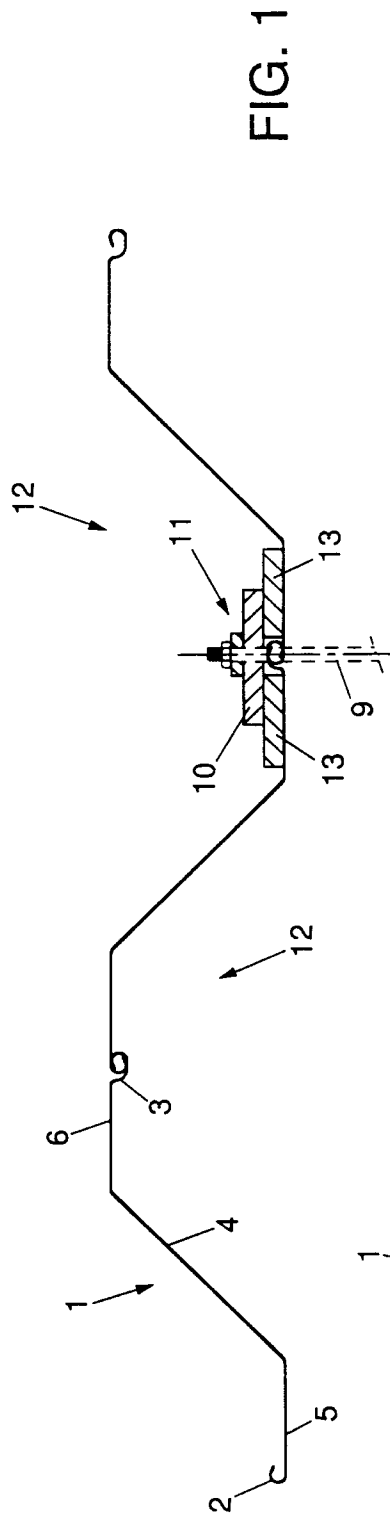
2. U-Profil-Pfahl zur Verwendung im Verfahren nach Anspruch 1, der sich aus zwei miteinander verbundenen Z-Profil-Pfählen (1) zusammensetzt, die jeweils durch Warmwalzen oder Kaltformgebung aus Stahl hergestellt worden sind und eine Querschnittsgestalt aufweisen, die sich aus zwei parallelen Endflanschen (5, 6) ungleicher Länge zusammensetzt, die ein geschrägter Zwischenabschnitt (4) miteinander verbindet, wobei die beiden Flansche an ihrem freien Ende jeweils mit einem Haken (2, 3) versehen sind und einer der Z-Profil-Pfähle um 180° um seine Längsachse relativ zum anderen Pfahl verdreht ist und das die beiden Z-Profil-Pfähle verbindende Schloß (2/3) aus der Achse (H-H) des Profilbodens (12) weit genug seitlich versetzt ist, daß sich auf diesem eine Ankerplatte (10) im wesentlichen auf der Achse (H-H) zentriert anordnen läßt.

Revendications

1. Méthode de fabrication d'un rideau de palplanches fait de palplanches (1) à section en Z emboîtées les unes aux autres, enfoncées dans le sol et ayant une forme de section composée de deux ailes d'extrémité parallèles (5,6) jointes par une partie intermédiaire inclinée (4), les deux ailes étant munies d'un crochet (2,3) sur leur extrémité libre, dans laquelle une sur deux desdites palplanches à section en Z a été tournée de 180° autour de son axe longitudinal par rapport à la palplanche voisine, en sorte de former des palplanches à section, en Ω s'emboîtant par les crochets (2,3) s'étendant sur toute la longueur de leurs bords li-

bres, et dans laquelle au moins l'une desdites palplanches en Ω est munie d'une plaque d'ancrage (10) dans son fond formant canal et sur un côté des crochets en emboîtement dans le but de positionner un ancrage (9), caractérisée en ce que les palplanches à section en Ω sont faites de paires de palplanches de section en Z préalablement soudées entre elles ayant, d'une manière connue en soi, leur partie intermédiaire inclinée (4) située entre deux ailes d'extrémité parallèles (5, 6) de différentes longueurs, en ce que la plaque d'ancrage (10) est située sur l'ailé (6) de plus grande longueur d'une palplanche pour être substantiellement centrée sur l'axe (H-H) du fond formant canal (12) de la palplanche de section en Ω , et en ce que les palplanches de section en Ω sont enfoncées ou insérées par vibration dans le sol, successivement ou par groupes.

2. Palplanche à section en Ω destinée à être utilisée dans la méthode selon la revendication 1, ladite palplanche à section en Ω étant composée de palplanches (1) à section en Z reliées entre elles, chacune fabriquée en acier par laminage à chaud ou façonnage à froid et ayant une forme de section qui est composée de deux ailes d'extrémité parallèles (5, 6) de longueur inégales, jointes par une partie intermédiaire inclinée (4), les deux ailes étant munies d'un crochet (2,3) à leur extrémité libre, l'une desdites palplanches à section en Z ayant été tournée de 180° autour de son axe longitudinal par rapport à l'autre palplanche, le verrou (2/3) qui relie lesdites deux palplanches (1) à section en Z étant suffisamment décalé latéralement par rapport à l'axe (H-H) du fond formant canal (12) pour y placer une plaque d'ancrage (10) substantiellement centrée sur ledit axe (H-H)



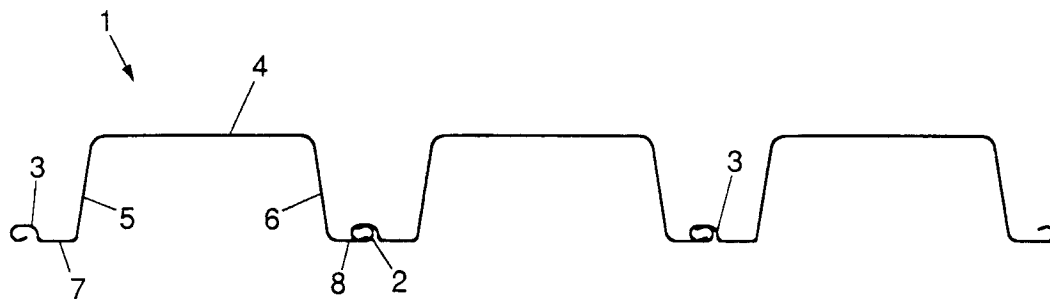


FIG. 3

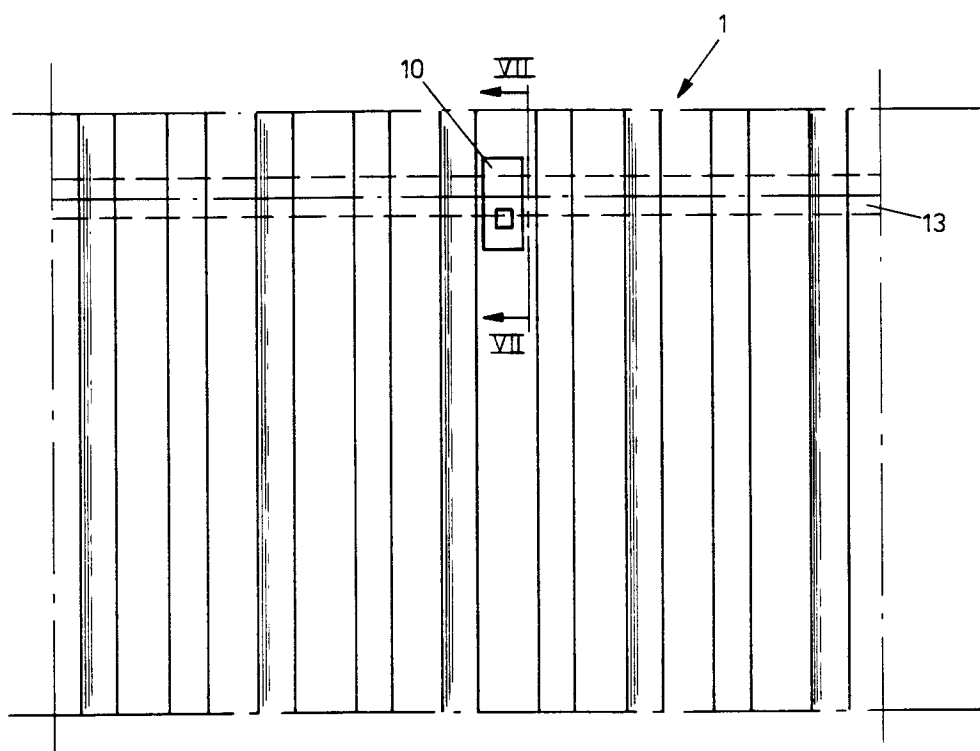


FIG.5

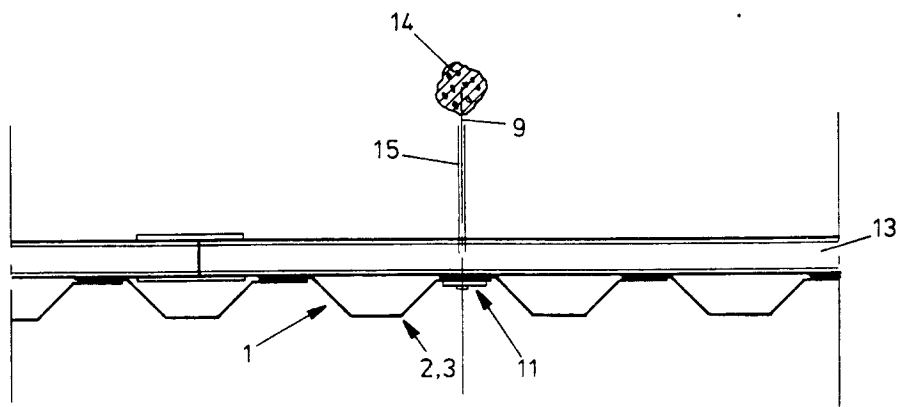


FIG.6

