(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 444 727 A1**

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **91200163.3**

(51) Int. Cl.[5]: **E02D 5/04**, E02D 5/74

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

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

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

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

(71) Applicant: **HOFFMANN BODEMTECHNIEK B.V.**
Beekerheide 18
NL-5741 HC Beek en Donk(NL)

(72) Inventor: **Jansen, Machiel Julius**
Zeewinde 8
NL-2403 GG Alphen a/d Rijn(NL)
Inventor: **Muller, Winnyfred Maria Jacoba**
Beekerheide 18
NL-5741 HC Beek en Donk(NL)

(74) Representative: **Smulders, Theodorus A.H.J., Ir. et al**
Vereenigde Octrooibureaux Nieuwe Parklaan 107
NL-2587 BP 's-Gravenhage(NL)

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

(57) A method of making sheet piling and sheet pile for use in this method, wherein Ω-section sheet piles made from pairs of Z-section sheet piles (1) previously welded together are driven or vibrated into the ground successively or in groups and wherein adjoining Ω-sheet piles interlock through the hooks (2,3) extending throughout the length of their free edges, **wherein** for making the Ω-section sheet piles (1 + 1) use is made of Z-section sheet piles (1) with the inclined intermediate portion (4) thereof located off the centre of the pile, so that on channel bottoms space has been created for mounting anchor seats directly against the channel bottoms.

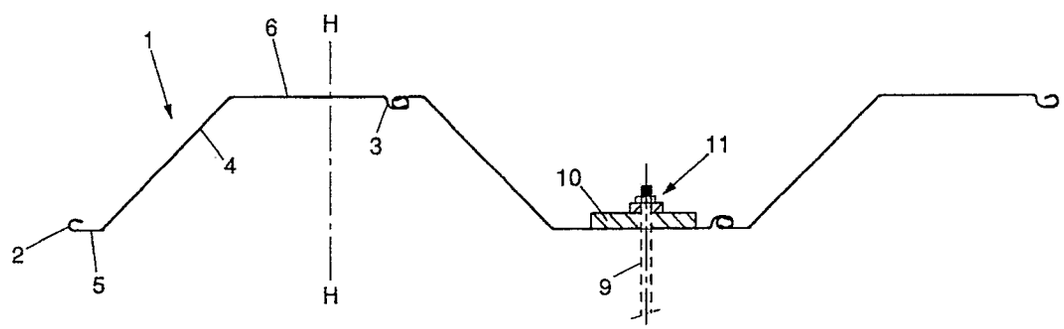


FIG. 4

EP 0 444 727 A1

A METHOD OF MAKING SHEET PILING, AND ASYMMETRIC-Z-SECTION SHEET PILE FOR USE IN SAID METHOD

The invention relates to a method of making sheet piling and to an asymmetric-Z-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 for making sheet piling, wherein Ω-section sheet piles made of pairs of Z-section piles previously welded together are driven or vibrated into the ground successively or in groups and wherein adjoining Ω-sheet piles interlock by means of the hooks extending throughout the length of their free edges, according to the invention, for making the Ω-section sheet piles, use is made of Z-section sheet piles with the inclined intermediate portion thereof located off the centre of the pile.

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 asymmmetrical 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 sheet piles having an asymmetrical Z-section for use in the method described above, which piles consist of a Z-shaped pile section, i.e. a pile formed from steel by hot rolling of cold formation, having a sectional form composed of two parallel end flanges connected by an inclined intermediate portion, the end flanges at their free ends being provided with a hook, wherein, according to the invention, the inclined intermediate portion is arranged off the centre of the pile, so that in a Ω-section pile composed of two of such Z-section piles, wherein one pile has been rotated through 180° about its longitudinal axis relative to the other pile, for the purpose of positioning an anchor plate, the lock connecting the two Z-section piles, is displaced laterally relative to the axis of the channel bottom.

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.

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 asymmetrical Z-section 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 retainig wall according to 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, in accordance with the invention, 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 asymmmetrical 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, wherein Ω-section sheet piles made from pairs of Z-section sheet piles (1) previously welded together are driven or vibrated into the ground successively or in groups and wherein adjoining Ω-sheet piles interlock through the hooks (2,3) extending throughout the length of their free edges, characterized in that for making the Ω-section sheet piles (1+1) use is made of Z-section sheet piles (1) with the inclined intermediate portion (4) thereof located off the centre of the pile.

2. A sheet pile for use in the method according to claim 1, provided with a Z-shaped pile section, i.e. a pile made from steel through hot rolling or cold formation, 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, characterized in that the inclined intermediate portion (4) is located off the centre of the pile (1), so that in a Ω-section pile composed of two of said Z-section piles, wherein one pile has been rotated through 180° about its longitudinal axis relative to the other pile, for the purpose of positioning an anchor plate (10), the lock (2/3) connecting the two Z-section piles (1), is displaced laterally relative to the axis (H-H) of the channel bottom (12).

FIG. 1

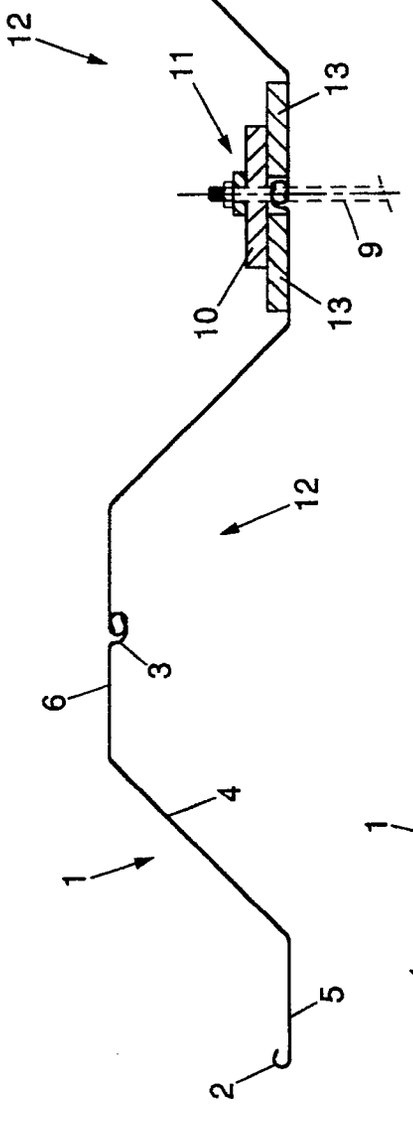


FIG. 2

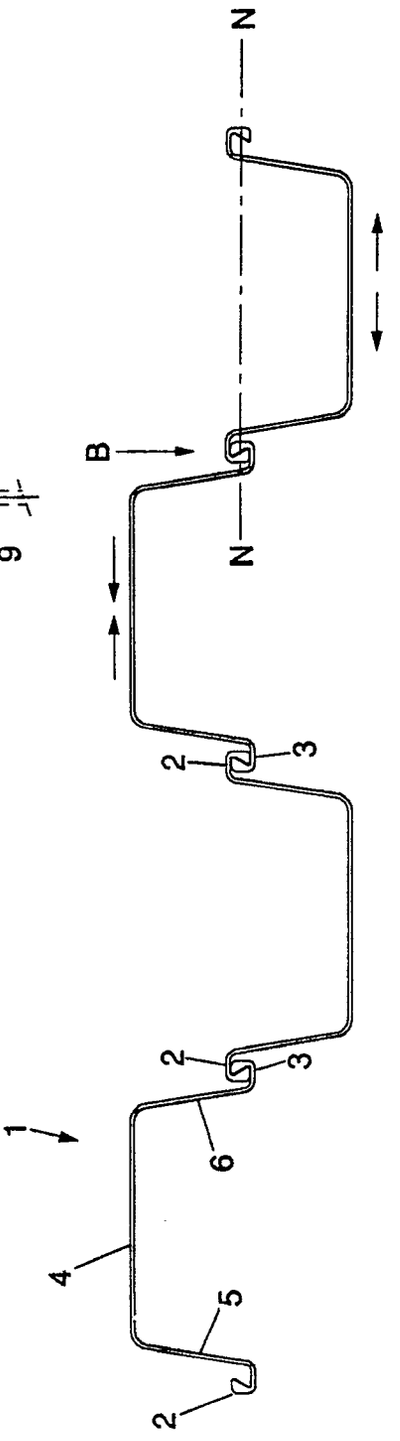
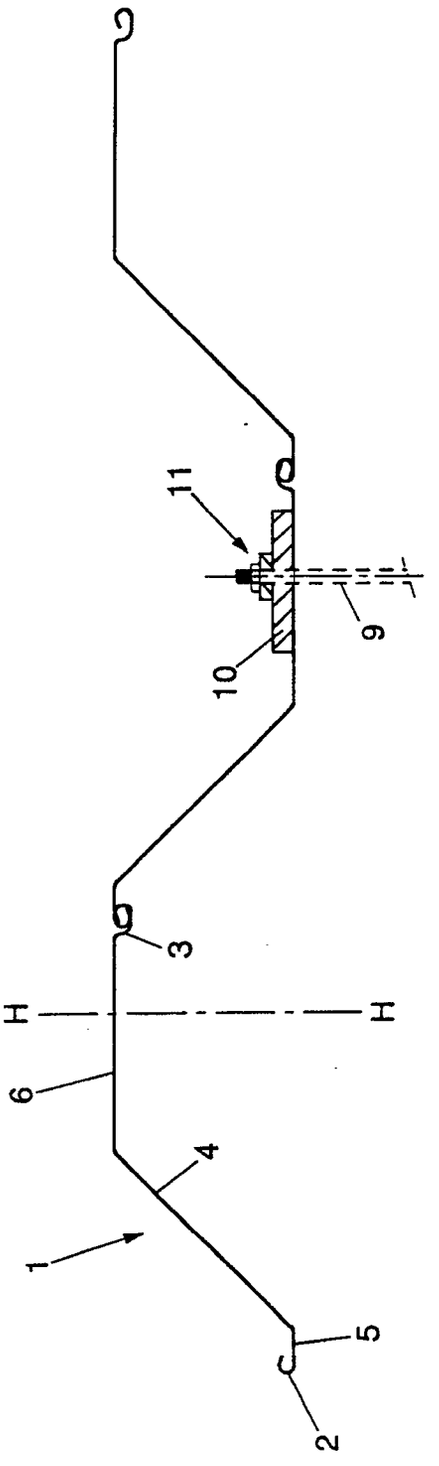


FIG. 4



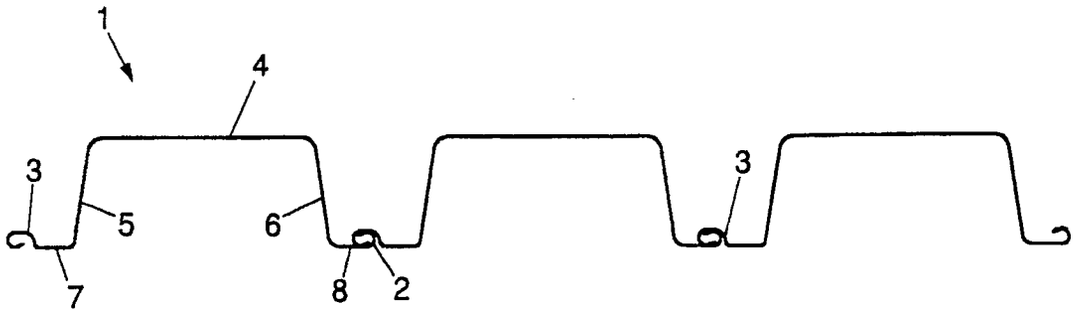


FIG. 3

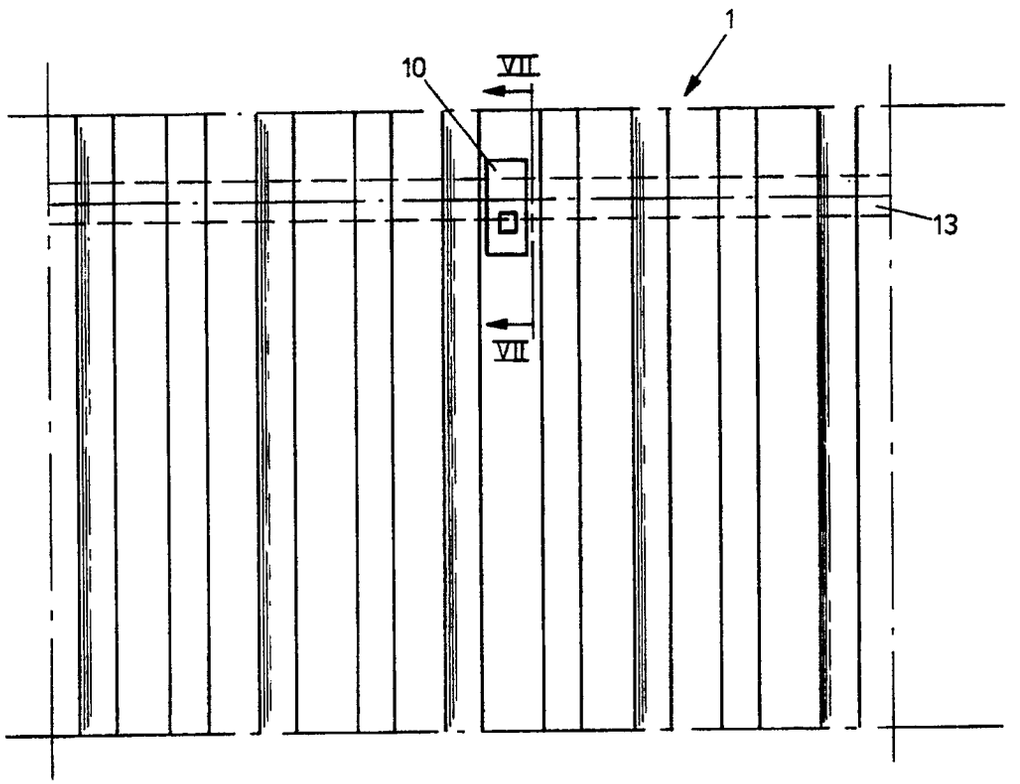


FIG.5

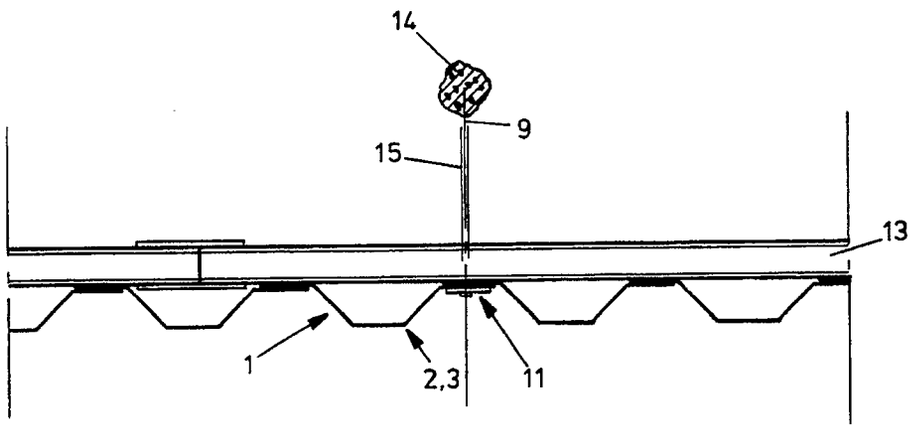


FIG.6

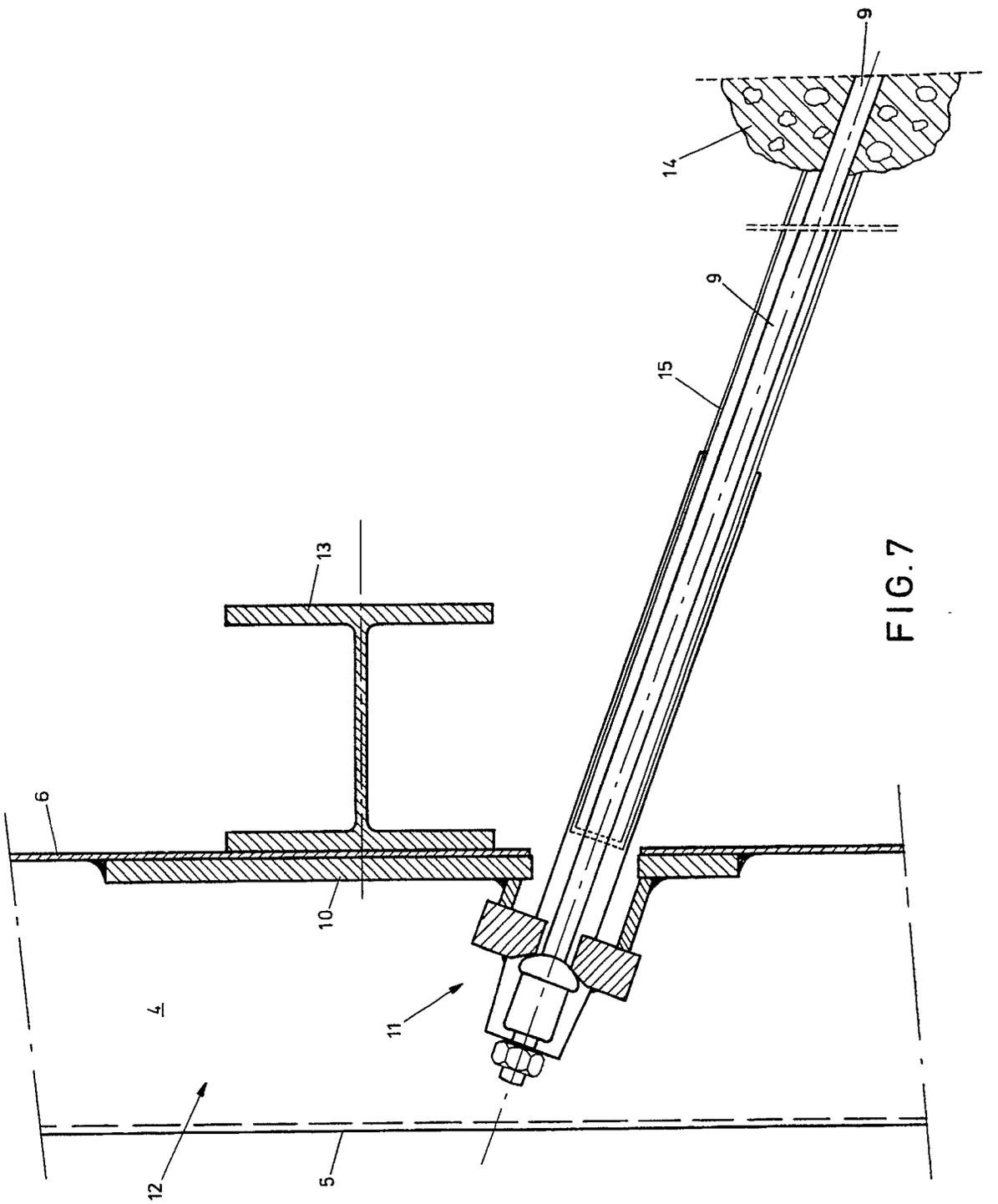


FIG.7

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 91 20 0163

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
D,X	DE-C-6 112 77 (WILLNER) * Whole document *	1,2	E 02 D 5/04 E 02 D 5/74
A	NL-C-2 317 0 (MAUTERER) * Whole document *	1,2	
A	LU-A-8 342 0 (COUTURIER) * Page 8, line 32 - page 9, line 3; figures 6,7 *	2	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

E 02 D

The present search report has been drawn up for all claims

Place of search	Date of completion of search	Examiner
The Hague	16 April 91	KERGUENO J.P.D.

CATEGORY OF CITED DOCUMENTS

X: particularly relevant if taken alone
Y: particularly relevant if combined with another document of the same catagory
A: technological background
O: non-written disclosure
P: intermediate document
T: theory or principle underlying the invention

E: earlier patent document, but published on, or after the filing date
D: document cited in the application
L: document cited for other reasons

&: member of the same patent family, corresponding document