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(54) **Sheet pile profile and sheet piling provided with an interlock member, and method therefor**

(57) The present invention relates to a sheet pile profile (4), sheet piling (2) and method for manufacturing interlock members (6,8) of a sheet pile profile (4). The sheet pile profile (4) according to the invention comprises:

- a profile part with a first and a second outer end;
- a first interlock member (6) arranged on the first outer

end; and

- a second interlock member (8) arranged on the second outer end,
- wherein the interlock members are bent ends (10,16,18,20) of the profile part, and wherein the bend radius is provided in the range of 6-10 mm, preferably in the range of 7-9 mm and is most preferably about 8 mm.

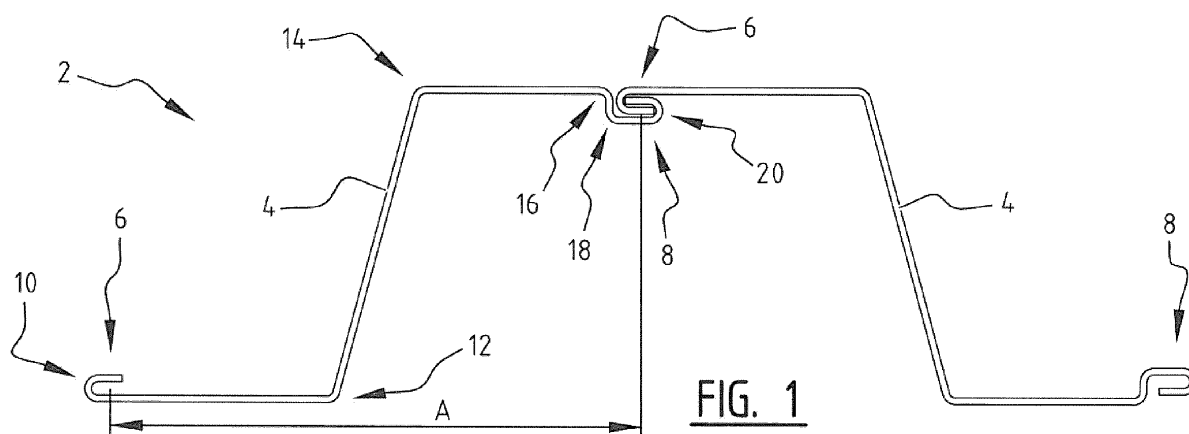


FIG. 1

Description

[0001] The present invention relates to an interlock member for a sheet pile profile. Such a sheet pile profile forms an earth-retaining construction which is inserted into the ground in substantially vertical manner and wherein a whole sheet piling is obtained by connecting separate sheet pile profiles. This connection of separate sheet pile profiles takes place with interlock members.

[0002] Known sheet pile profiles are manufactured by hot or cold deformation of sheet material. Known profile types are the so-called U-profile and Z-profile. For the purpose of obtaining a sheet piling, two adjacent sheet pile profiles are mutually connected using the adjoining interlock members which, when assembled, form an interlock. Such an interlock member is welded to a profile part of a sheet piling or is realized by rolling or bending the outer end of such a profile part. A problem occurring in practice in realizing a cold-formed interlock from interlock members of two adjacent sheet pile profiles lies in the clearance occurring between the separate interlock members. This clearance makes a movement possible between adjacent sheet pile profiles and increases the danger of leakages through the sheet piling.

[0003] The present invention has for its object to provide an interlock member wherein two adjacent sheet pile profiles can be joined to each other in effective and efficient manner and wherein the chance of the above stated problems is reduced.

[0004] The present invention provides for this purpose an interlock member for a sheet pile profile, wherein the interlock member comprises:

- a profile part with a first and a second outer end;
- a first interlock member arranged on the first outer end; and
- a second interlock member arranged on the second outer end,

wherein the interlock members are bent ends of the profile part and wherein the bend radius is provided in the range of 6-10 mm, preferably in the range of 7-9 mm and is most preferably about 8 mm.

[0005] Providing a sheet pile profile from a profile part with a first and second outer end, wherein a first male interlock member and a second female interlock member are arranged by bending the ends of the profile parts correspondingly, achieves first of all that such a sheet pile profile can be manufactured by cold deformation using rolling and/or bending.

[0006] The bend radius of the interlock members is preferably also provided in a range of 6-10 mm, preferably 7-9 mm and most preferably about 8 mm, for the purpose of hereby realizing a relatively precisely specified interlock member. Surprisingly, it has been found that a good placing of the sheet pile profiles is possible by providing a bend radius in said range.

[0007] In the past bends were made with relatively large bend radii for the purpose of manufacturing relatively open interlock members. The sheet pile profiles were then placed herewith in the ground. During placing a sheet pile profile as it were slides in vertical direction into the interlock member of an adjacent, already placed sheet pile profile. The interlock members known in practice are aimed at providing a relatively large clearance in order to simplify this placing. Surprisingly, it has now been found that, when a relatively limited bend radius is provided, the placing is simplified rather than being made more difficult since a better guiding is realized during placing of a sheet pile profile.

[0008] A further additional advantage of limiting the bend radius is that a substantially watertight, or at least more watertight, interlock is realized between two adjacent interlock members. This enhances the functionality of the overall sheet piling, and thereby also of the individual sheet pile profiles. It has been found that a bend radius of particularly about 8 mm is highly suitable and results in a good placeability of a sheet pile profile and a good watertightness.

[0009] The sheet pile profile according to the invention is preferably a so-called WRZ profile. This is a cold-rolled type of sheet pile profile. It has been found that particularly the use of the interlock members in a sheet pile profile according to the invention of the WRZ type reduces or even wholly obviates existing problems occurring in practice.

[0010] In an advantageous preferred embodiment according to the present invention an interlock opening is provided at the interlock member in the range of 14-18 mm, preferably 15-17 mm, and the interlock opening is most preferably about 16 mm.

[0011] Realizing a smaller bend radius and, associated therewith, realizing an interlock opening in the stated ranges achieves that an improved seal is realized between the two sides of a sheet pile profile. It has been found here that an angular displacement between two adjacent sheet pile profiles is also significantly limited. The overall sheet piling with sheet pile profiles manufactured according to the invention can hereby be placed in precise manner.

[0012] In an advantageous preferred embodiment according to the present invention the first and second interlock members are provided in complementary form and the ends of the interlock members extend substantially in a direction parallel to the main direction of a profile part, i.e. in longitudinal direction of the profile part or substantially in a vertical direction after placing of the profile part in a sheet piling.

[0013] Two adjacent sheet pile profiles can be mutually connected in relatively simple manner by providing a sheet pile profile with two complementary interlock members, i.e. a male interlock member and a female interlock member.

Bending the ends of the interlock members here such that the free ends extend in a direction substantially parallel to substantially the width direction of the profile part, i.e. in the substantially horizontal direction of the overall sheet piling, and wherein the free ends of the interlock members are directed toward their own profile part, achieves that a more compact and effective interlock can be realized between two adjacent sheet pile profiles. This improved interlock is realized in use due to the direction of the ends of the separate interlock members, which in this way lie alongside and against each other better for the purpose of realizing a better seal. It has also been found that the force transmission between the interlock members is greatly improved with this specific form of the interlock members. It has been found that the seal, and in particular the watertightness, is hereby significantly improved compared to the sheet pile profiles known in practice and associated interlock members.

[0014] In a further advantageous preferred embodiment of the present invention the second interlock part is provided with a second opening in the range of 12-18 mm, for instance 14-16 mm and is most preferably about 15 mm.

[0015] Providing a second opening in the second female interlock member achieves a further improved seal, and thereby improved watertightness. This is caused by the relatively small second opening, so that there is less open space through which leakage of groundwater can for instance occur.

[0016] In a further advantageous preferred embodiment according to the present invention the sheet pile profile is a Z-profile in which all interlock members are provided on a side of the profile such that the interlocks formed in use lie a minimal distance from the central line of the sheet piling.

[0017] Owing to the use of a Z-profile the interlocks lie on either side of the central line of the formed sheet piling. A stable sheet piling is hereby realized. The interlock members are preferably also mounted on the profiles such that in use the interlocks are formed on the side of the profile parts facing toward this central line. The profile parts on which the interlocks are provided preferably lie substantially mutually in line owing to the correct configuration of the interlock members. This prevents, among other problems, the possibility of adjacent sheet pile profiles as it were pulling each other out of alignment or otherwise moving each other out of position. It has been found that a better leak-tightness can in this way be realized. This leak-tightness is particularly improved by giving the second opening of the second interlock member a size of about 15 mm. Surprisingly, it has been found that sheet pile profiles can hereby be placed in the ground.

[0018] The sheet pile profiles with the interlock members according to the invention are preferably pressed instead of vibrated into the ground. It has been found surprisingly that, when the sheet pile profiles according to the invention are pressed into the ground, the friction occurring during the placing remains limited. In addition, side-effects of vibration, including vibrations transmitted to the surrounding area and possible damage caused thereby, are avoided.

[0019] The invention further relates to a sheet piling provided with two or more sheet pile profiles as described above.

[0020] The sheet piling provides the same effects and advantages as those stated in respect of the sheet pile profile.

[0021] The invention further also relates to a method for manufacturing an interlock for sheet pile profile, comprising the steps of:

- providing a profile part with a first and a second outer end;
- arranging a first interlock member on the first outer end and a second interlock member on the second outer end by bending ends of the profile part;

wherein at least one of the interlock members is bent with a bend radius of 6-10 mm, preferably 7-9 mm, and most preferably about 8 mm.

[0022] The method according to the invention provides the same effects and advantages as those stated in respect of the sheet pile profile and the sheet piling. The first and second interlock members are preferably provided with the same bend radius. The same bend can hereby be formed on both outer ends of the profile part. The bending is preferably performed by cold-rolling of the profile part. In an advantageous embodiment the first male interlock part is realized here with a single bending. The second female interlock member is preferably also realized with three bendings. An interlock member can hereby be manufactured with a limited number of bendings. The free ends of the separate interlock members preferably extend here in a direction substantially parallel to the direction of the sheet pile profile, and thereby enhance the effect of the assembled sheet piling. It has been found that in relatively simple and surprising manner an improved watertightness is hereby also realized compared to existing interlock members.

[0023] In a further advantageous preferred embodiment according to the present invention the interlock member of the sheet pile profile is pressed during placing into an interlock member of an adjacent sheet pile profile. It has been found that applying a narrower interlock with less clearance compared to most conventional sheet pile profiles, pressing of the sheet pile profiles into the ground, wherein the interlock members are pressed into an already placed interlock member, can be readily realized without friction forces being greatly increased. The leak-tightness of the overall sheet piling obtained from the sheet pile profiles according to the invention is in this way greatly improved.

[0024] Further advantages, features and details of the invention are elucidated on the basis of preferred embodiments thereof, wherein reference is made to the accompanying drawing, in which:

- figure 1 shows a view of an interlock between two adjacent sheet pile profiles according to the invention;
- figures 2A and B show views of the first and second interlock members according to the invention; and
- figures 3A and B show views of interlock members according to the prior art.

[0025] A sheet piling 2 is provided from a number of sheet pile profile 4. In the shown embodiment sheet pile profiles 4 are of the WRZ 18-635 type and provided with a first male interlock member 6 and a second female interlock member 8. Sheet pile profile 4 is manufactured by bending and/or rolling, wherein a first bending 10 is performed at the first interlock member 6. A second operation is realized at bend or curve 12, followed by a further operation at bend or curve 14. Female interlock member 8 is realized by bends or curves 16, 18 and 20. It is of course possible to provide the interlock members in the form of interlock members 6, 8 on other profile types, for instance other dimensions of the WRZ type sheet pile profile and in other shapes, such as the U-type profile.

[0026] For the purpose of realizing a sheet piling 2 a first sheet pile profile 4 is placed in the ground. A second sheet pile profile 4 is then placed from above adjacently of the already placed sheet pile profile 4, wherein a male interlock member 6 is hooked into the second female interlock member 8 of the adjacent sheet pile profile 4.

[0027] In the shown embodiment sheet pile profiles 4 are of a specific type. A number of the specific dimensions are stated in the following table.

Table 1: Dimensions

Size	mm	Size	mm	Size	mm
A	635	I	37	P	15 (2 nd opening)
B	8	J	44	Q	8
C	32	K	12	R	52
D	Radius 8	L	8	S	68
F	8	M	Radius 8	T	8
G	8	N	8	U	Radius 8
H	45	O	16 (1 st opening)	V	Radius 8

[0028] The dimensions stated in the table correspond of course to the specifically chosen profile types for sheet pile profile 4. Other types can result in a different dimensioning.

[0029] The free outer end of interlock member 6,8 is however preferably provided here in a direction parallel to the (in use horizontal) main direction of profile part 4 corresponding to the working width of the sheet piling 2 manufactured from separate sheet pile profiles 4. It is noted by way of comparison that in the same type of sheet pile profile of the WRZ 18-635 type in existing configurations/dimensioning use is made of a bend radius of 11 degrees for the male interlock member 6 and even 13 degrees for the female interlock member 8. Other dimensions also differ, including interlock opening O which amounts to 13 mm for the male interlock member 6 and to 21 mm for the second interlock opening 8, and wherein the height of interlock member 6 (C) amounts to 38 mm and to 41 mm for the female interlock member 8 (J).

[0030] With the new dimensioning according to present invention a tighter fit is realized, whereby clearance is countered. This improves the watertightness. Surprisingly, the guiding during placing of sheet pile profiles is simultaneously also improved. The force transmission is also improved.

[0031] In the manufacture of a sheet pile profile according to the invention use is preferably made of a profile part which is given the desired form as described above by means of a number of cold deformations. In dimensions for the stated WRZ 18-635 type this results in a sheet pile profile with a width of 635 mm, a height of 380 mm and a thickness of 8 mm. Applicable for a steel section of the piling is a value of 137.5 cm²/m, a weight for a single plank or sheet pile profile 4 of 68.5 kg/m. This results in a weight of 108.0 kg/m² for the whole sheet piling 2.

[0032] In a test for leak-tightness the stated sheet pile profile of type WRZ 18-635 according to the invention was compared to the conventional, also cold-rolled sheet pile profile of type WRZ 16-635 (figures 3A and 3B of respectively a male and female interlock member). The conventional interlock members have bend radii of 11 mm for the male member and 13 mm for the female member. The interlock member outer ends are also bent relative to the direction in which the profile part substantially extends. The second opening in the female second interlock member is about 21 mm.

[0033] The leakage tests were performed at atmospheric pressure, at 0.5 bar, 1.0 bar and 1.4 bar overpressure. Using the instrumented threaded ends the sheet pile profiles were placed under tensile stress.

[0034] This situation will also occur in practice since earth will be excavated on one side of the sheet piling, whereby a column of ground, possibly saturated with water, will press against the sheet piling. The sheet pile profiles are supplied

with a length of 0.3 m and are provided with plates welded thereto to enable the tensile force to be applied to the interlock. The tensile force is applied with four threaded rods provided with resistance strain gauges. It is hereby possible to carry out all the tests to be performed with equal tensile force on the interlock.

[0035] Performing of the tests is identical for both embodiments. A polycarbonate cover is adhered over the interlock with silicone sealant. All seams on the inner side are then filed with silicone sealant, after which the cover is adhered thereto with silicone sealant. Mounted on the cover is a calibrated pressure sensor which is connected to the space under the cover. The cover is further provided with a compressed air connection. All the seams on the outer sides are then sealed with silicone sealant, after which the silicone sealant cures for two days.

[0036] The end surfaces of the cover are fixed with a glue clamp. The sides of the cover are fixed with adjusting plates. The cover is pressed as a whole onto the sheet pile profile with four wooden wedges. Water is then carried from above the sheet pile profile into the cover. In the test at atmospheric pressure the water is in open connection with the ambient air. The water which seeps through the interlock for a determined period of time is collected in a drip-tray. The collected water is then weighed.

[0037] When performing the leakage tests under pressure the pressure in the cover is adjusted using a pressure reduction valve. The pressure is read on a measuring amplifier. The quantity of leaked water per unit time is also measured while performing the tests under pressure.

[0038] A pressure sensor, PICAS measuring amplifier and MGC+ data loops are further provided.

[0039] The results are shown in tables 2 and 3.

Table 2: Tensile force on interlock for tests without swelling paste.

Type of interlock	Threaded rod 1 (kN)	Threaded rod 2 (kN)	Threaded rod 3 (kN)	Threaded rod 4 (kN)	Force on interlock total (kN)
WRZ 18-NL635	7.6	7.4	7.8	7.7	30.5
WRZ 16-635	7.6	7.4	7.6	7.4	30.0

Table 3: Results of leakage tests steel interlocks without swelling paste.

Type of interlock	Without swelling paste (L/min.m)			
	Atmosphere(bar)	0.5 (Bar)	1.0 (Bar)	1.4 (Bar)
WRZ 16-635	0.15	5.4	13.2	19.8
WRZ 18-NL635	0.04	2.1	6.7	11.9

[0040] The results show the effect of the interlock according to the invention. The leak-tightness is considerably increased with this interlock, even by about 40% relative to comparable conventional interlocks under the same conditions.

[0041] The sheet pile interlock according to the invention was also tested with swelling paste. The object of the swelling paste is to further reduce leakage of water through the interlock.

[0042] In the configuration in which swelling paste is applied, this paste is arranged on both sides of the interlock after it has been roughly cleaned with a wire brush. The swelling paste is of the Adeka Ultra seal: P-201 type. The two parts are slid together after the swelling paste has been applied, whereby excess applied paste is pressed out. The swelling paste then has to cure for at least 10 hours. Following curing, the interlock with swelling paste is placed in water in order to swell for 7 to 10 days. After swelling of the paste the tensile stress is applied to the interlock by means of the instrumented threaded ends and the tests are performed.

[0043] The tests with swelling paste show that the leak-tightness is hereby further increased and even that no leakage was detected in the present case.

[0044] The present invention is by no means limited to the above described embodiment thereof. The rights sought are defined by the following claims, within the scope of which many modifications can be envisaged. It is thus possible for instance to weld the interlock members according to the invention on or at a sheet pile profile. In addition to application with the "Z-plank" as shown in the figures, the invention can also be applied with a so-called "U-plank" and to other cold or hot formed sheet pile profiles 4.

Claims

1. Sheet pile profile, comprising:

- a profile part with a first and a second outer end;
 - a first interlock member arranged on the first outer end; and
 - a second interlock member arranged on the second outer end,
- wherein the interlock members are bent ends of the profile part, and wherein the bend radius is provided in the range of 6-10 mm, preferably in the range of 7-9 mm and is most preferably about 8 mm.

2. Sheet pile profile as claimed in claim 1, wherein an interlock opening is provided in the range of 14-18 mm, preferably about 15-17 mm, and is most preferably about 16 mm.

3. Sheet pile profile as claimed in claim 1 or 2, wherein the first and the second interlock member are provided in complementary form, and wherein the ends of the interlock members extend substantially in a direction parallel to a main direction in the length of the profile part.

4. Sheet pile profile as claimed in claim 1, 2 or 3, wherein the second interlock member is provided with a second opening in the range of 12-18 mm, preferably 14-16 mm and is most preferably about 15 mm.

5. Sheet pile profile as claimed in one or more of the foregoing claims, wherein the profile is a cold-rolled profile.

6. Sheet pile profile as claimed in one or more of the foregoing claims, wherein the profile is a Z-profile, and wherein all interlock members are provided on one side of the profile such that the interlocks formed in use lie a minimal distance from the central line of a sheet piling.

7. Sheet pile profile as claimed in one or more of the foregoing claims, wherein the interlock members are formed such that they can be pressed into the ground.

8. Sheet piling provided with a sheet pile profile as claimed in one or more of the foregoing claims .

9. Method for manufacturing interlocks of a sheet pile profile, comprising the steps of:

- providing a profile part with a first and a second outer end;
 - arranging a first interlock member on the first outer end and a second interlock member on the second outer end by bending ends of the profile part;
- wherein at least one of the interlock members is bent with a bend radius of 6-10 mm, preferably 7-9 mm, and most preferably about 8 mm.

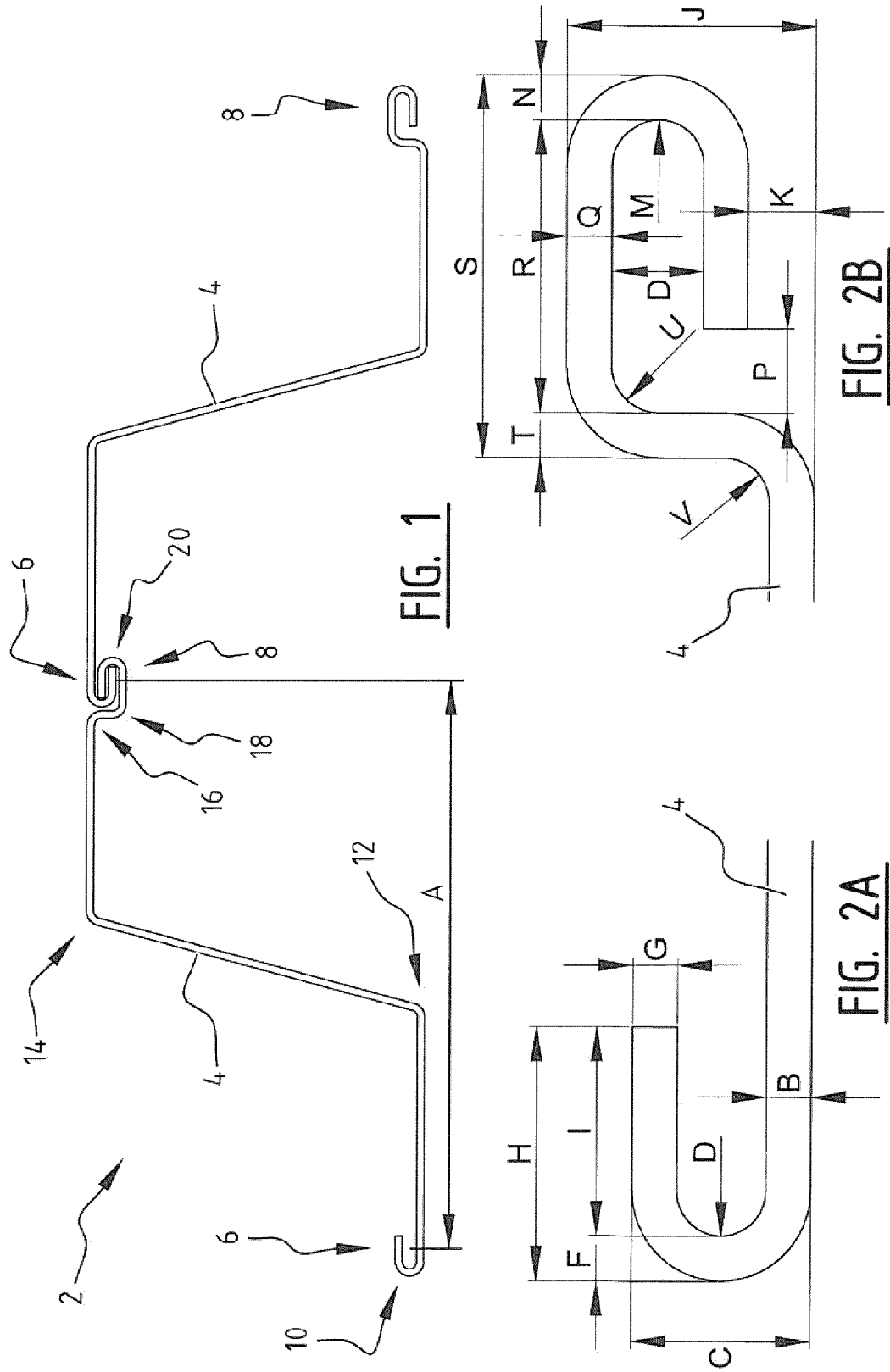
10. Method as claimed in claim 9, wherein the first and second members are provided with the same bend radius.

11. Method as claimed in claim 9 or 10, wherein the bending is performed by cold-rolling of the profile part.

12. Method as claimed in claim 9, 10 or 11, wherein the first interlock part is realized with a single bending.

13. Method as claimed in one or more of the claims 9-12, wherein the second interlock member is realized with three bendings.

14. Method as claimed in one or more of the claims 9-13, wherein during placing the interlock member of the sheet pile profile is pressed into an interlock member of an adjacent sheet pile profile.



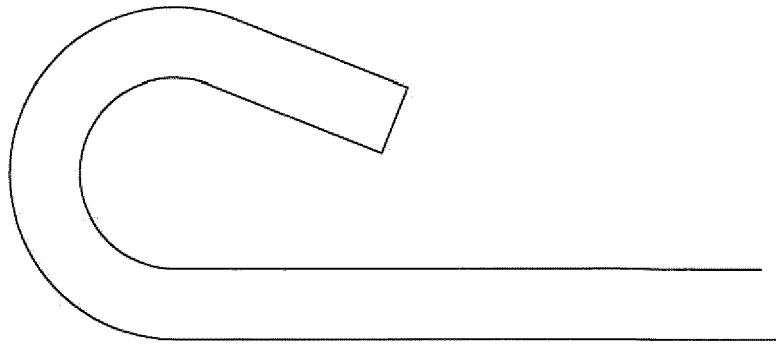


FIG. 3A
PRIOR ART

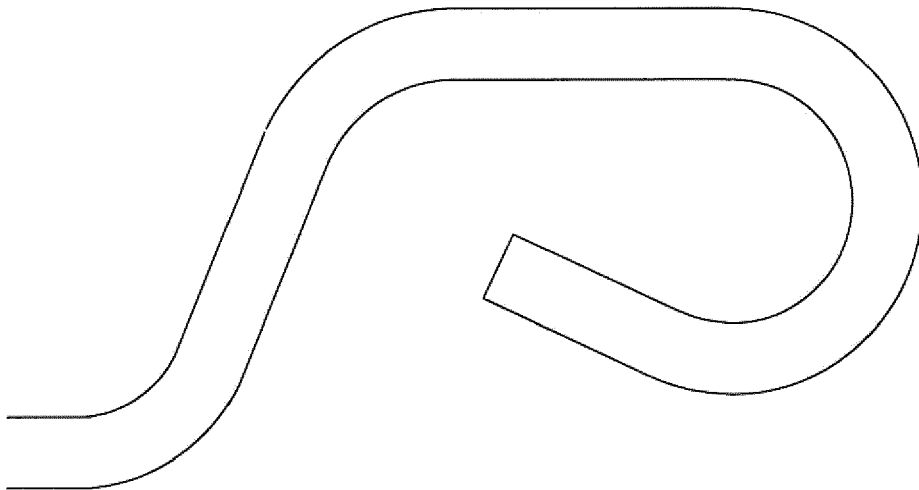


FIG. 3B
PRIOR ART



EUROPEAN SEARCH REPORT

Application Number
EP 12 16 7543

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	EP 0 806 524 A1 (KVH VERBAUTECHNIK GMBH [DE]) 12 November 1997 (1997-11-12)	1,2,4,5,7-11,13,14	INV. E02D5/04 E02D5/08
Y	* column 6, line 17 - column 7, line 5; figures 6,7 *	3,6,12	
Y	FR 2 613 960 A1 (L EST PROFILES TUBES [FR]) 21 October 1988 (1988-10-21) * claim 1; figures 5,6,12 *	3,6,12	
A	WO 2009/126016 A1 (HALTEREN INFRA B V VAN [NL]; VAN HALTEREN TIJMEN [NL]) 15 October 2009 (2009-10-15) * page 7, lines 12-19 *	3,12	
			TECHNICAL FIELDS SEARCHED (IPC)
			E02D B21D
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 2 July 2012	Examiner Leroux, Corentine
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category 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	

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EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 12 16 7543

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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02-07-2012

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
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