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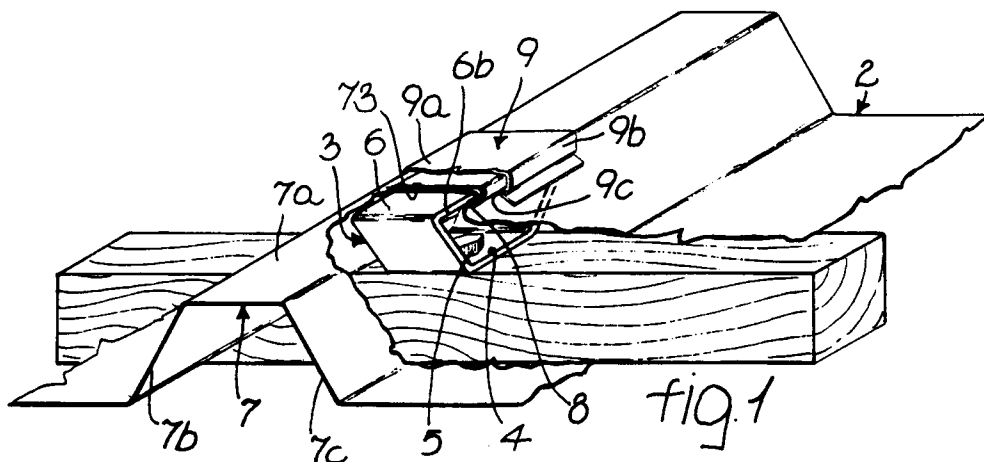
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I-20123 Milano(IT)(54) **Process for anchoring a metallic covering made of corrugated plate, covering structure obtained by the process, and apparatus for performing the process.**

(57) The process for anchoring metallic coverings made of corrugated plate (2) to an underlying supporting structure (1) includes the steps of pre-arranging and rigidly fixing to the supporting structure (1) a plurality of under-corrugation supporting and anchoring elements (3) which each define a pair of sliding support sides (6), the laying of the plate (2) with the respective corrugation (7) arranged astride the supporting and anchoring element (3), and the lateral clamping, with permanent deformation (8), of the corrugation against and around the sides (6) of the supporting and anchoring element (3). The resulting

covering structure comprises the plate (2) which is well anchored to the supporting structure (1) while allowing a mutual sliding between the plate (2) and the anchoring and supporting element (3) which is facilitated by the use of a plain bearing (73) interposed therebetween. An apparatus for performing the process includes two mutually articulated jaws (32,33) which, when arranged above and astride a corrugation (7) and actuated, force the corrugation to deform against and around the sides (6) of the anchoring and supporting element (3).

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The present invention relates to a process for anchoring metallic coverings made of corrugated plate to an underlying supporting structure, to the covering structure obtained by such process and to an apparatus for performing said process.

As is known, in conventional coverings of buildings, performed with metallic corrugated plates, the anchoring of the plates to the underlying supporting structure of the covering normally requires the perforation of the plate, the insertion of an appropriate screw, provided with a head or cap and an underlying gasket, through each hole of the plate, and the fixing, by screwing, of each screw until it is completely tightened in and against the supporting structure.

After application, the plates are exposed to the inclemency of the weather, and due to the thermal expansions and contractions they change in length according to parameters which are very different from those of the supporting understructure.

This creates unwanted stresses at the couplings (screws), which very often cause the widening or slotting of the holes in the plates, compromising watertightness, since it facilitates the penetration of meteoric water between the screw and the hole, or the fatigue breakage of the screws because they are subjected to repeated shearing-stress cycles in alternated directions, or also the unscrewing of the screws from the supporting structure, especially in the very frequent cases of wood supporting structures.

The loosening of part of the screws can occur also due to treading compression, which can interrupt the seal between the gasket and the respective accommodation seat, especially in the cases of ovalization of the holes affected by the compression.

It is furthermore necessary to take into account the fact that, in practice, the plate-layer sometimes makes mistakes in perforating the plate, i.e. produces holes which are not exactly located at a supporting element, so that he is then forced to define new holes in the correct position and to plug the wrong ones. However, these pluggings, as is known, in the long run always constitute potential leakage points in the covering.

Furthermore, in the case of steel plates, even if protected by zinc-coating and painting, the perforations expose the steel along the sides of the holes and usually constitute preferential and early regions for attack by rust, which then spreads in all directions, causing the separation and the lifting of the layers of protective material, with the consequent considerable reduction of the useful life or durability of the covering.

The aim of the present invention is to provide a process and means for anchoring metallic coverings made of corrugated plate which are capable of

completely eliminating the disadvantages described above with through-screw anchorings.

An object of the present invention is to provide a process and means for anchoring which allow the metallic plates to perform limited movements which are sufficient to compensate the dilations/contractions due to environmental heat variations, but ensure a constant retention grip thereon.

Another object of the present invention is to avoid the need to perforate the metallic plates for said anchoring process and means.

Not least object of the present invention is to provide a said process which is easy to perform and can be carried out at competitive costs.

According to a first aspect of the present invention, a process is provided for anchoring metallic coverings made of corrugated plate to an underlying supporting structure, which entails: the pre-arrangement and the fixing to the supporting structure of a plurality of under-corrugation supporting and anchoring elements, each of which has two sliding sides which extend parallel to the corrugation to be supported; the laying of the plate or plates with the respective corrugations arranged astride at least one supporting and anchoring element, and the lateral clamping, with permanent deformation, of the or each corrugation around the sides of the or each supporting element, with the possibility of sliding along said supporting elements, although it remains rigidly coupled to the supporting and anchoring element or elements.

Advantageously, during or after clamping, at least one retention device, suitable for maintaining a forced clamping between the corrugation and the supporting and anchoring element, is applied onto the plate or plates.

According to another aspect of the present invention, a covering made of corrugated plate is provided which is supported by a supporting structure and comprises a plurality of under-corrugation supporting and anchoring elements, each of which has two sliding sides which extend parallel to the corrugation to be supported and around which a portion of corrugation which is permanently deformed inward slidingly engages.

Advantageously, at each under-corrugation supporting and anchoring element there is at least one retention device which is suitable for arranging itself astride the corrugation in order to keep it slidingly clamped around the sides of the supporting and anchoring element. Each supporting and anchoring element can furthermore comprise a slider which is slidingly mounted thereon and acts as sliding anchoring body on which the corrugation is fixed.

Further aspects and advantages of the present invention will become apparent from the following

detailed description of some preferred but not exclusive embodiments thereof, illustrated only by way of non-limitative example in the accompanying drawings, wherein:

figure 1 is a partially sectional perspective view of a portion of covering according to the invention, anchored to a supporting and anchoring element;

figure 2 is a sectional elevation view of a portion of corrugated covering with a retention clamp according to a first embodiment of the invention; figure 3 is an axonometric view of a movable anchoring body which is intended to be slidingly mounted on an under-corrugation support;

figure 4 is a schematic sectional view of a portion of corrugated covering according to another embodiment of the invention and of a tool for deforming the corrugations;

figure 5 is a view, similar to figure 4, but of a different deformation tool;

figure 6 is a view, similar to figure 2, but of a different retention clamp;

figure 7 is a view, similar to figure 2, but of another retention clamp;

figure 8 is a view, similar to figure 2, related to a further retention clamp;

figure 9 is a partial plan view of figure 8;

figure 10 is an elevation view of a deformation-percussion tool;

figure 11 is a sectional view, taken along the line X-X of figure 10;

figure 12 is a sectional view, taken along the line XII-XII of figure 10; and

figure 13 is a perspective view of a portion of covering anchored by using the deformation tool of figure 10.

In the following description and in the drawings, identical or similar parts or components have been indicated by the same reference numerals.

In the figures, the reference numeral 1 generally indicates a longitudinal beam, for example made of wood, of a supporting structure for a corrugated plate covering 2. A plurality of under-corrugation supporting and anchoring elements 3 is fixed to the supporting structure 1, and each is for example constituted by a bracket with a trapezoid-like configuration, which is fixed at its smaller parallel side 4 to a beam 1 by means of one or more screws 5, so that its larger parallel side 6 constitutes a supporting surface for the intrados of a corrugation 7 of the plate 2. Generally, a corrugation 7 has a flat top 7a flanked by two identical lateral wings 7b and 7c which are specularly symmetrical with respect to the centerline.

Once the plate or plates 2 has or have been placed so that each corrugation 7 rests on a plurality of brackets 3, the upper part of the lateral wings 7b and 7c is clamped and slightly permanently

deformed, without breaking it, by means of an appropriate clamping tool (for example such as those described hereinafter), against and around a portion of the sides 6a and 6b of the face 6 of the bracket, so as to obtain two opposite recesses 8 in the corrugation, which thus remains anchored to the bracket but is free to slide over and along its face 6 in order to discharge the stresses and imbalances which are produced in the plate 2 due to the thermal expansions and contractions.

If one wishes to ensure a firmer and more durable grip between the corrugation 2 and the bracket 3, it is possible to provide a retention bridge or clip 9 which is arranged astride the corrugation and engages, in a snap-together manner, in its deformed lateral portions or recesses 8. The clip 9 can be for example made of steel or of another suitable metallic alloy or can be made of plastic material, and can have a planar intermediate portion 9a which is intended to abut against the flat top 7a of a corrugation 7 and two lateral wings 9b which are folded at 90° and are affected by a longitudinal recess 9c which is intended to enter, in a snap-together manner and so as to define an undercut, a respective recess 8 of a corrugation. The clip 9 is therefore easy to insert in place even without using tools.

In order to reduce friction and therefore wear and the consequent risk of breakage of the corrugation 7 indeed in the weakened region constituted by the recesses 8 against the sides 6a and 6b and said face 6 of the bracket 3, it is advantageously possible to provide a plain bearing 73 between the corrugation 7 and the bracket 3.

Said bearing can be constituted for example by a strip of stainless steel or of another metallic alloy which has two edges wrapped around the sides 6a and 6b of the bracket 3 so as to be able to slide easily along the face 6 of the bracket.

When the two recesses 8 are formed by means of a clamping tool, the corrugation is anchored to the bearing 73, so that the sliding produced by the thermal expansion or contraction of the plate occurs between the bearing 73 and the bracket 3 instead of between the plate and the bracket, to the full advantage of the integrity and durability of the plate.

The embodiment illustrated in figures 2 and 3 comprises under-corrugation supporting and anchoring elements 10, each of which is constituted by a portion of a profiled element which is made of metal or of plastic material and has a widened resting base 11, a double stem 12 which internally delimits an opening 13, and a flat head 14 with two lateral protruding sides 15. The profiled element 10 can be fixed to the supporting structure 1 by means of one or more screws 5 which pass through a respective hole in the flat head 14 and in

the base 11.

A slider 16 is slidably mounted on the head 14 and is made for example of a suitable plastic material or metallic alloy. The slider 16 is configured so as to engage the head 14 of the profiled element from below as well, so as to be anchored thereto in a coulisse-like manner. For this purpose, it has a lower groove 17 which is provided with two side walls 17a and 17b the respective free edges 17c and 17d whereof are directed inward, so that they define two undercut shoulders intended to engage the sides 15 of the profiled element 10.

Externally, each shoulder 17a, 17b has a longitudinal undercut 18 against which the corrugation 7 is deformed. In an upward position, the slider 16 has a planar face 19 which is affected by one or more slots 20 so as to not interfere with the head 5a of the screw or screws 5.

The slider 16 is slidably fitted on the head of the profiled element 10 by inserting it from one end of the profiled element. A corrugation 7 is placed above one or more sliders 16 thus installed and is laterally clamped and deformed above and around each slider 16 so as to create therein two recesses 8 which mate with, and engage against, the undercuts 18 of the slider.

In order to ensure a more firm and durable grip between the corrugation and the slider 16, it is possible to provide a retention device, constituted by a clamp 21 which can be arranged above and around the corrugation 7 at each slider 16. The clamp 21 is formed by two jaws 22 and 23 which are intended to engage the recesses 8 of the corrugation and constitute an edge of two rigid surfaces with different curvatures which are held together by a transverse screw 26. When the screw is tightened, it moves the surfaces 24 and 25 mutually closer, forcing at the same time the jaws 22 and 23 to clamp against the recesses 8 and thus against the undercuts 18 of the slider 16, thus rigidly associating the plate 2 with the slider 16, therefore with the possibility of performing longitudinal movements along the profiled element 10.

Each one of figures 4 and 5 illustrates an embodiment, similar to the one of figures 2 and 3, and two different manual clamping tools, a clamp-like one 30, and a compass-like one 40 which is actuated manually by means of a crank 41 which turns a transverse threaded shaft 42 which can be screwed in a complementarily threaded block 43, or is actuated automatically by means of a motor. Each clamping tool is provided with jaws 32 and 33 which are intended to deform the wings 7b and 7c of the corrugations against and around the undercuts 18 of the sliders 16.

The supporting and anchoring element 10 is anchored to the supporting structure 2 by means of a screw 5 which abuts exclusively against the base

11. The slider 16 is provided with lateral undercuts 18 which, in use, stay at a higher level than the head 14 of the profiled element 10, and the body of the slider 16 is hollow, with a longitudinal opening 160.

Figure 6 is a view of an embodiment which is similar to the one of figures 4 and 5 and wherein the retention device is formed by a clamp 45 which has two jaws 46 and 47 which are mutually articulated along a transverse axis 48, to which a threaded traction element 49 is also articulated; a nut 50 can be screwed on said traction element 49 and is suitable for abutting, by means of an enlarged head 51, against the jaws 46 and 47 to clamp them against the corrugation 7.

The embodiment of figure 7 is also similar to the one of figures 4 and 5, but it has a clamp 55 with jaws 56, 57 which can abut above the centerline of the corrugation 7 and can be coupled to one another by a bolt 58. The clamp 55 can be secured in position by the jaws 32, 33 of a deformation tool 30 or 40, so that the deformation of the plate occurs together with the securing of the clamp.

Figures 8 and 9 illustrate a retention clamp 60 which can also act as securing tool. It comprises a profiled element 61 which can be arranged astride a corrugation and has a fixed jaw 62 on one side of the corrugation and a movable jaw 63, slidably mounted in the profiled element, on the other side.

An eccentric element 64 is provided adjacent to the movable jaw 63, is mounted so as to be able to rotate about an axis X-X and can be actuated by means of a wrench by acting on one of its ends 65, which has a square cross-section and protrudes from the profiled element 61. By rotating the eccentric element 64, for example by 180°, the jaws 62 and 63 are clamped and thus the corrugation 7 is permanently deformed against the undercuts 18 of the slider 16.

In the case of plates 2 made of steel or of aluminum alloy and having a considerable thickness and strength, the deforming or clamping tool can be provided with a percussion device in order to facilitate the permanent deformation of the corrugations. An example of such a tool is illustrated in figures 10 to 12, wherein the reference numeral 70 indicates a clamp with two jaws 71 and 72 which are mutually articulated by means of a pivot 73. Each of the jaws 71 and 72 has a respective actuation arm 74 and 75 which is in turn pivoted to a rod, respectively 76 and 77. The rods 76 and 77 are mutually articulated by means of a pivot 78, so that the jaws, together with the arms 74, 75 and the rods 76, 77, constitute an articulated quadrilateral.

A striking element 79 is arranged along the direction of the diagonal which joins the pivots 73 and 78 and has, at one end, a slot 81 in which a percussion element 82 of adjustable length is

slidingly arranged. The percussion element 82 supports the articulation pivot 78 and is rigidly associated with a fork 83 which is connected to a percussion device, for example a pneumatic hammer or another source of oscillating-vibrating motion, generally indicated by 84.

The percussion element 82 has a percussion head 85 which is intended to strike a short wall 81a of the slot 81 in the striking element 79. Said striking element 79 is instead provided with an enlarged striking head 87 which arranges itself between the jaws 71 and 72 but in a rearward position with respect to their grip region.

In use, the tool 70 is capable of performing a repeated hammering of the top surface 7a of a corrugation simultaneously with the repeated clamping of the jaws 71 and 72 against the wings of the corrugation. Each percussion motion in the direction of the axis y-y in figure 10 is in fact converted both into a blow of the head 87 on the corrugation and into a sudden clamping motion of the jaws 71 and 72, by virtue of the articulated-quadrilateral connection through the pivot 78. All this leads to the result of a compression effect on the corrugation, which causes the forming of a depression 90 (figure 13) of the top of the corrugation, and this allows the material of the corrugation to better deform around and below the sides of a support 3 or 10 or around and below the sides of a bearing 73 or of a slider 16, without breaking and producing recesses 8 which are well-shaped and have a well-defined depth and length (their length is naturally smaller than that of the base 6 in the case of trapezoid-like supports 3, as in figures 1 and 13).

If required, the tool 70 can be provided with manual operation by means of handgrips 88 and 89.

It can be seen that the process and covering described above overcome the need to perforate the corrugated plate, which in conventional systems constitutes the most penalizing disadvantage due to the tightness problems which arise therefrom. The plates are furthermore ensured the possibility of compensating the expansion/contraction elements in a safe and durable manner especially by virtue of the coulisse-like anchorings of the covering to the supporting structure, which avoid the wear of plates by friction.

The invention described above is susceptible to numerous modifications and variations within the protective scope defined by the content of the claims.

The materials and the dimensions may be various according to the requirements.

Where technical features mentioned in any claim are followed by reference signs, those reference signs have been included for the sole pur-

pose of increasing the intelligibility of the claims and accordingly such reference signs do not have any limiting effect on the scope of each element identified by way of example by such reference signs.

Claims

1. Process for anchoring metallic coverings made of corrugated plate (2) to an underlying supporting structure (1), which entails: the pre-arrangement and the fixing to the supporting structure of a plurality of under-corrugation supporting and anchoring elements (3;10), each of which has two sliding sides (6;15) which extend parallel to the corrugation (7) to be supported; the laying of the plate (2) or plates with the respective corrugations (7) arranged astride at least one supporting and anchoring element (3;10), and the lateral clamping, with permanent deformation (8), of the corrugations (7) against and around the sides (6;15) of the respective supporting element or elements (3;10), with the possibility, for the or each corrugation (7), of sliding along said supporting and anchoring elements (3;10), although it remains rigidly coupled to the supporting and anchoring element or elements.
2. Process according to claim 1, characterized in that it comprises the pre-arrangement, on each supporting and anchoring element (3;10), of at least one plain bearing element (73) or slider (16) around which the clamping and permanent deformation of a respective corrugation (7) are performed.
3. Process according to claim 1 or 2, characterized in that it comprises an operation of percussion at the top of each corrugation (7) while its lateral clamping is performed, with deformation (90) around a supporting and anchoring element (3;10) or around a bearing (73) or slider (16).
4. Process according to any one of claims 1 to 3, characterized in that during or after clamping, at least one retention device (9;21;45;55;60), suitable for maintaining a forced clamping between the corrugation (7) and the supporting and anchoring element (3;10), is applied on the plate (2) or plates.
5. Covering made of corrugated metal plate (2), intended to be supported by a supporting structure (1), said covering comprising a plurality of under-corrugation supporting and anchoring elements (3;10), each of which has two

sliding sides (6;15) which extend parallel to the corrugation (7) to be supported, a portion (8) of corrugation (7) which is permanently deformed inward engaging against and around said sides.

6. Covering according to claim 5, characterized in that the or each supporting and anchoring element (10) comprises at least one slider element (16) which is slidingly mounted in a coulisse-like manner thereon and acts as supporting and fixing element for the intrados of a respective corrugation (7). 10
7. Covering according to claim 5, characterized in that a steel bearing (73) is inserted at the deformed portion (8) between the corrugation (7) and the supporting and anchoring element (3). 15
8. Covering according to claim 6, characterized in that each slider element (16) is formed by a profiled element which has a guiding groove (17) for sliding on the respective supporting element (10) as well as two outer undercut lateral recesses (18) against which the corrugation (7) engages by clamping and permanent deformation. 20
9. Covering according to any one of claims 5 to 8, characterized in that at least one retention device (9;21;45;55;60) is provided at each under-corrugation supporting and anchoring element (3;10), said retention device being suitable for arranging itself astride the corrugation (7) in order to keep it slidingly clamped against and around the sides of the supporting and anchoring element (3) or of the slider element (16). 25
10. Covering according to one or more of claims 5 to 8, characterized in that said retention device comprises a bridge or clip (9) which can be inserted on the corrugation (7) in a snap-together manner. 30
11. Covering according to any one of claims 5 to 8, characterized in that said retention device comprises a clamp (21) which has two jaws (22,23) formed by two curved rigid surfaces which have different curvatures and are partially superimposed, and a locking screw (26) which can be screwed on both surfaces above the corrugation (7). 35
12. Covering according to any one of claims 5 to 8, characterized in that said retention device comprises a clamp (45) which has two jaws 40

(46,47) which are mutually articulated about a common axis, a traction element (49) which is articulated on said common axis and a female thread or nut (50) which can be screwed on the traction element and abuts against the jaws, so as to clamp them against the corrugation (7). 45

13. Covering according to any one of claims 5 to 8, characterized in that said retention device comprises a clamp (55) which has two jaws (56,57) which can abut and be fixed by a transverse fixing screw (58) above the corrugation (7). 50
14. Covering according to any one of claims 5 to 8, characterized in that said retention device comprises a C-shaped profiled element (60) which can be arranged astride a corrugation (7) and has a fixed jaw (62) which is intended to engage one wing of the corrugation, a movable jaw (63) which is intended to engage the other wing of the corrugation, and an eccentric pusher (64) for the movable jaw which is suitable for forcing said jaw against the corrugation. 55
15. Apparatus for performing the process according to any one of claims 1 to 4, characterized in that it comprises two mutually articulated jaws (32,33;46,47;56,57;62,63; 71,72), which are suitable for arranging themselves above and astride a corrugation (7), and actuation means for forcing said corrugation to deform against two lateral recesses or indents of a supporting element (3;16). 60
16. Apparatus according to claim 16, characterized in that it comprises a percussion device (82) for facilitating the deformation of the corrugation (7) and its compression from above. 65
17. Apparatus according to claim 17, characterized in that said percussion device (82) comprises a striking element (79) which is slidingly mounted on an articulation pivot for the jaws (71,72) and has a striking head (87) proximate to the jaws, a percussion element which is slidingly mounted on the striking element so as to abut thereon and is pivoted, so as to define an articulated quadrilateral, to two jaw actuation arms (74,75), and a source of vibrating-oscillating motion (84) for the source of vibrating-oscillating motion (84) for the percussion element, so that the latter, by virtue of the vibrations-oscillations of said source, strikes the striking element, which in turn strikes the top of a corrugation (7) and at the same time 70

actuates the jaws so that they repeatedly clamp against said corrugation.

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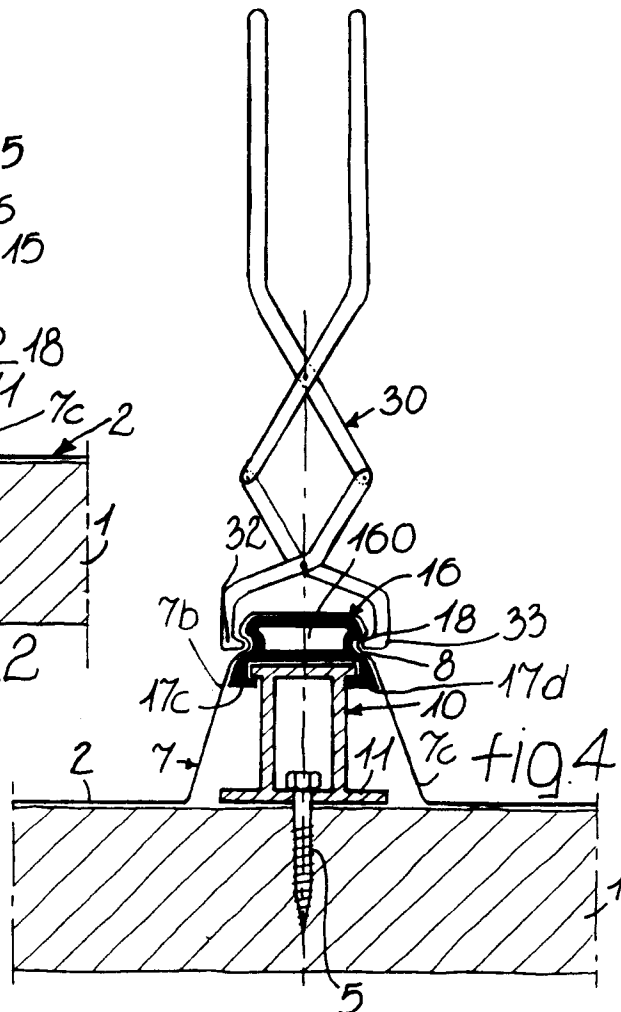
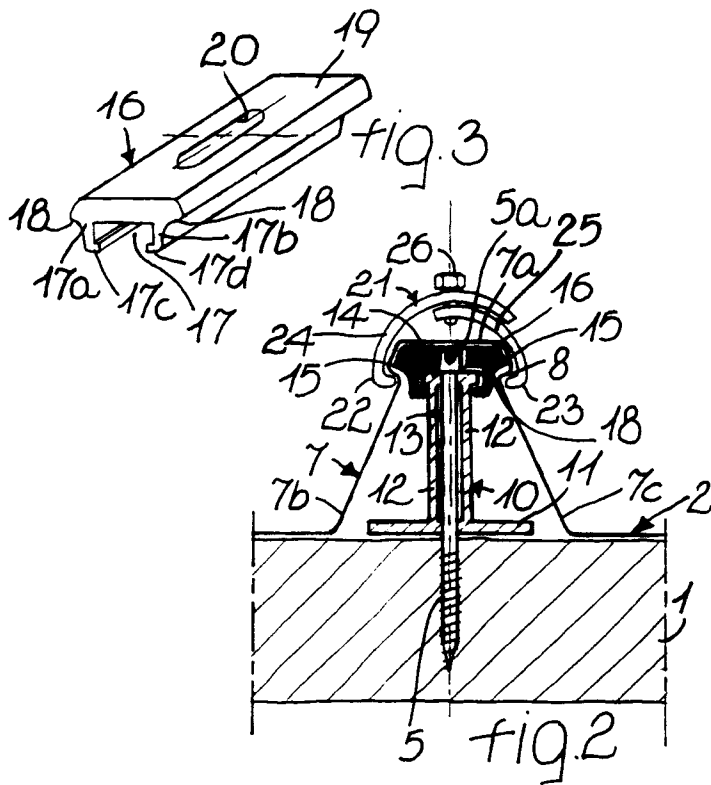
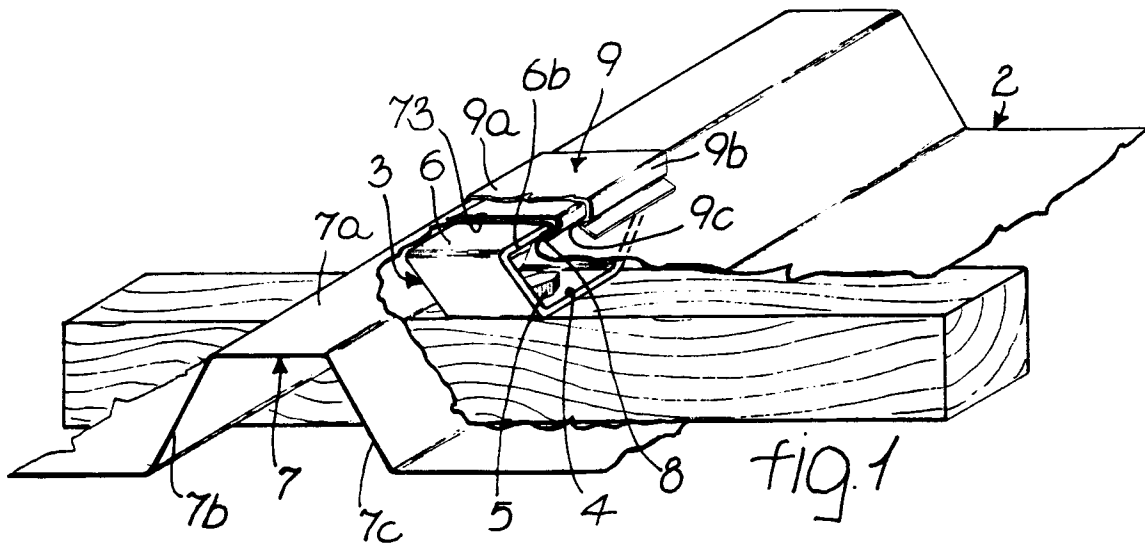
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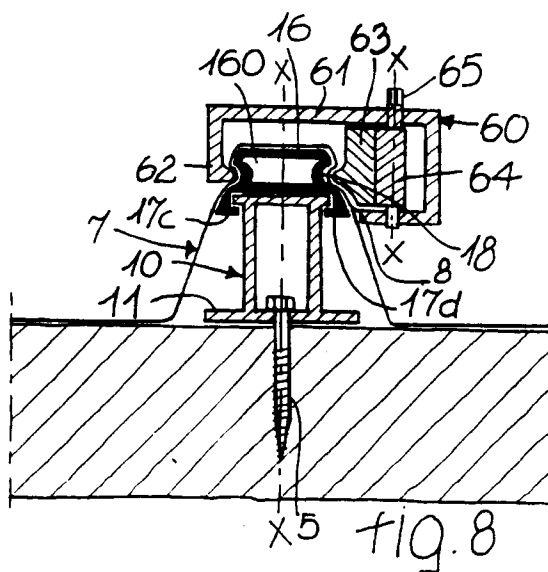
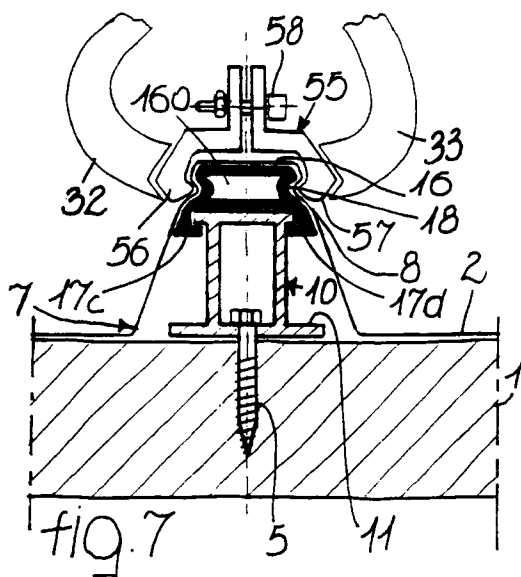
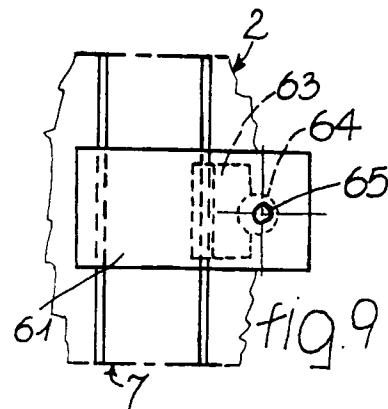
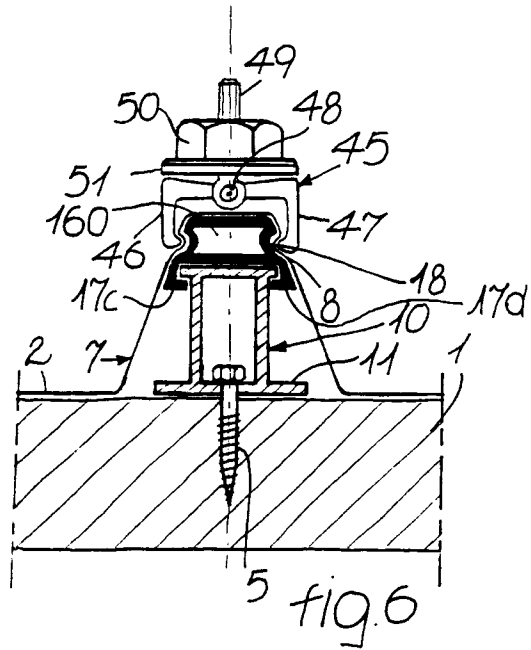
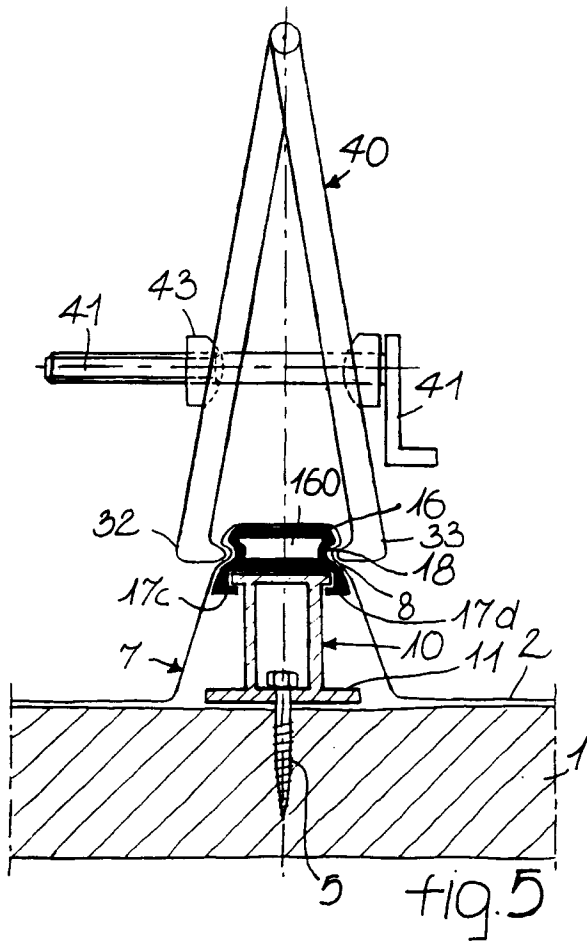
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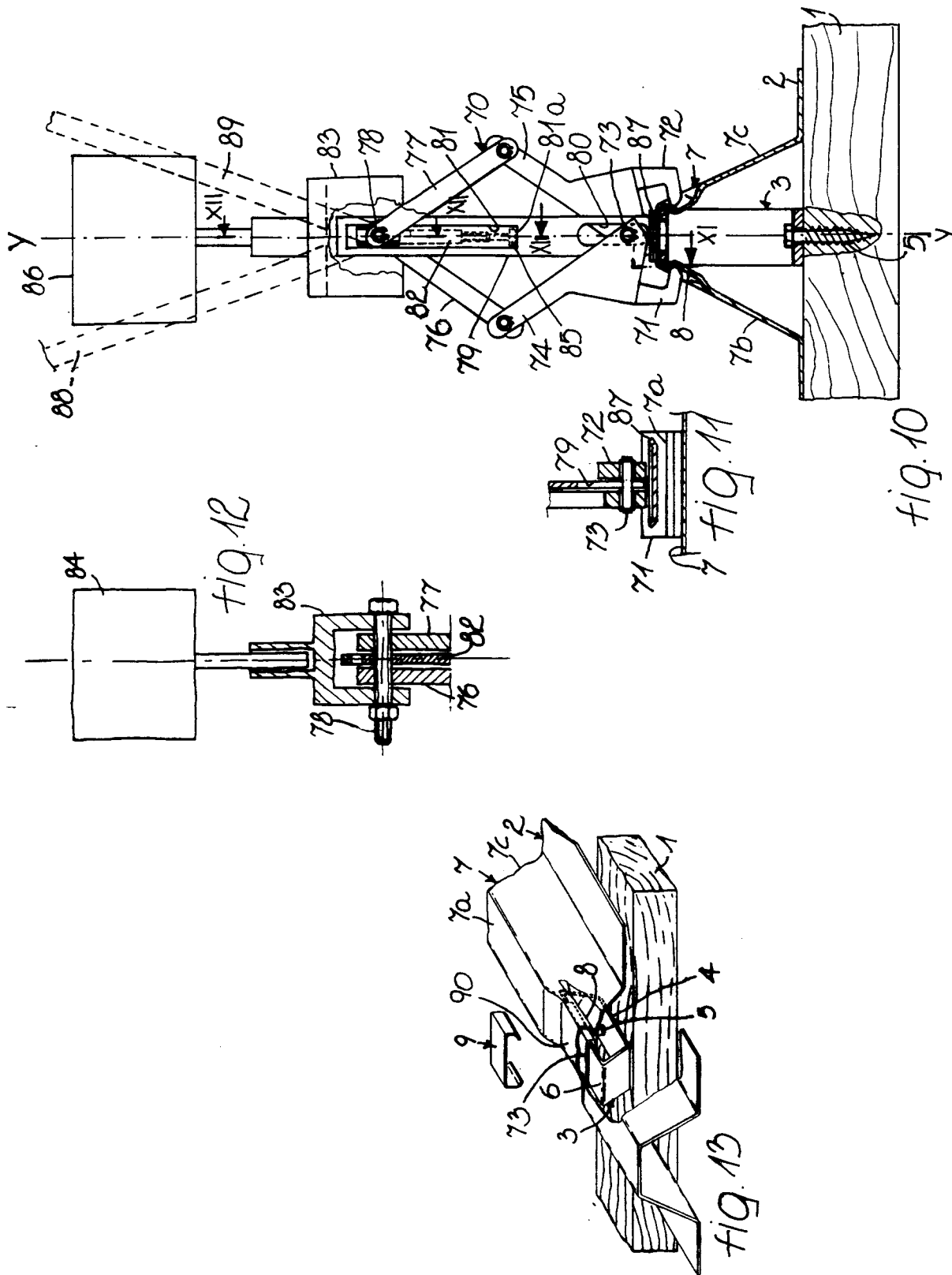
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EUROPEAN SEARCH REPORT

Application Number

EP 91 11 5476

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)
X	US-A-2 360 879 (W.KROIER)	1,3-5,7,9, 10,15,16	E 04 D 3/36 E 04 D 15/04
Y	---	2,6	
A	US-A-2 360 879 () * page 1, column 2, line 17 - page 3, column 1, line 22; figures 1-16 **	8,11-14, 17	
P,Y	WO-A-9 112 392 (STRAMIT IND.) * page 21, paragraph 4 - page 22, paragraph 3; figures 1-5,31,32 **	2,6	
A	EP-A-0 097 327 (ROBERTSON BAUELEMENTE) * abstract; figures 1-3,7 **	1,2,5,6	
A	US-A-4 064 819 (FOX) * column 3, line 37 - column 4, line 59; figures 1-9 **	15-17	
A	FR-A-2 021 371 (ALCAN R&D) * claim 6; figures 1-9 **	1,5	
A	US-A-3 641 729 (IRVIN) * abstract; figures 1-7 **	1,15	TECHNICAL FIELDS SEARCHED (Int. Cl.5)
A	CH-A-128 792 (E.HOFFMANN) * figures 1-3 **	1,15	E 04 D
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of search 19 December 91	Examiner RIGHETTI R.
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			