

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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(21) International Application Number: PCT/SE92/00076 (22) International Filing Date: 7 February 1992 (07.02.92) (30) Priority data: 9100391-3 8 February 1991 (08.02.91) SE (71)(72) Applicants and Inventors: LÖNNÖ, Anders [SE/SE]; Virebergsvägen 9, S-171 40 Solna (SE). GRIP, Sven [SE/SE]; Oxenstiernas väg 85, S-184 32 Åkersberga (SE). DOLK, Åke [SE/SE]; Revyvägen 24, S-142 43 Trångsund (SE). (74) Agent: GRIP, Sven; Oxenstiernas väg 85, S-184 32 Åkersberga (SE).		(81) Designated States: AT, AT (European patent), AU, BB, BE (European patent), BG, BR, CA, CH, CH (European patent), CS, DE, DE (European patent), DK, DK (European patent), ES, ES (European patent), FI, FR (European patent), GB, GB (European patent), GR (European patent), HU, IT (European patent), JP, KP, KR, LK, LU, LU (European patent), MC (European patent), MG, MN, MW, NL, NL (European patent), NO, PL, RO, RU, SD, SE, SE (European patent), US. Published <i>With international search report.</i> <i>In English translation (filed in Swedish).</i>	
(54) Title: METHOD AND ARRANGEMENT FOR FORMING A LOAD-BEARING JOINT BY MEANS OF COMPRESSED CELLULAR PLASTIC MATERIAL THAT HAS BEEN MADE TO EXPAND BY HEATING			
(57) Abstract The present invention is a method for forming load-bearing joint s through the use of a compressed cellular plastic material (3) having a stable form at room temperature, and which, after insertion into the joint area (1), is made to expand through heating so that the whole of the joint area is filled. Bonding between the filler material and the base material can be secured by means of a hot melt adhesive or a hot melt adhesive with setting agent (4) which, during the expansion phase of the filler material, melts under elevated temperature, and thereby a bond is formed between the filler material and the base material (5). Through this method, when the filler material heats up, the joint area is filled, pressure is exerted on the adhesive, and bonding to the base material is secured at one and the same time. With the present method, the components comprising the joint are dry when being handled. The method is applicable for the load-bearing joining of core material in sandwich constructions. It can also be used for joining concrete panels, wall panels, window panels, etc. in building construction.			

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METHOD AND ARRANGEMENT FOR FORMING A LOAD-BEARING JOINT BY MEANS OF COMPRESSED CELLULAR PLASTIC MATERIAL THAT HAS BEEN MADE TO EXPAND BY HEATING

The present invention is a method for forming load-bearing joints through the use of compressed cellular plastic material having a stable form at room temperature, and which, after insertion into the joint area, is made to expand through heating so that the whole of the joint area is filled. Bonding between the filler material and the base material can be secured by applying a one or
5 two-component adhesive. Alternatively, bonding can be secured by means of a hot melt adhesive or a hot melt adhesive with setting agent which, during the expansion phase of the plastic filling material, melts under elevated temperature, and thereby a bond is formed between the filler material and the base material.

10 Through this method, when the filler material heats up, the joint area is filled, pressure is exerted on the adhesive, and bonding to the base material is secured at one and the same time. Furthermore, with the present method, the components making up the joint are dry when being handled.

The method is applicable for the load-bearing joining of core material in sandwich constructions, but it is also applicable for joining concrete panels, wall panels, window panels
15 etc. in building constructions.

STATE OF THE ART

There are a number of methods for filling joints areas. The following are examples of methods
20 that have already been patented: U.S. 3,806,566; U.S. 4,898,630; U.S. 4,647,716; DE A 1,963,267; and DE A 1,784,467.

Common to most of the above methods, however, is that their purpose is primarily to fill or seal a cavity, gap or enclosed space, and not to form a load-bearing joint. Furthermore, most of the methods are based on a chemical process, e.g. foaming or vulcanization. The present
25 method is based instead on storing energy in the form of compressed gas at room temperature, which energy is then released at elevated temperature (the heat distortion temperature of the plastic filler material).

In patent No. DE A 1,784,467, a non-chemical sealing method is described. The method is based on the compression of an elastic cellular plastic material having open cells. The method
30 is not applicable for forming a rigid, load-bearing joint. Furthermore, the plastic material used in the method, when compressed, does not have dimension stability at room temperature.

U.S. Patent 4,647,716 describes a method that is similar to the present method. However, even in this case the purpose is to seal.

In order to obtain a sealed electrical connection, compressed cellular plastic material is
35 placed between the wires and the shrink tube which completely encloses the connector. Thereafter, the connector is heated in a conventional manner. It is reasonable to suppose that heating is by means of a hot air gun, by which means the tubing shrinks and the piece of cellular plastic material expands, thus sealing the connector. The patent also refers to the possibility of applying hot melt adhesive to the cellular plastic material (called sealing member in the patent),
40 thereby further ensuring that adequate sealing will be obtained. Thus, the above-cited patent describes a method for sealing electrical connectors and is not a method for forming a load-bearing joint.

EXAMPLES OF APPLICATIONS

Present method:

5 Cellular plastic material is used as core material in sandwich constructions. Ships and boats, for example, are often constructed in accordance with this principle. The core material is fixed to a wooden construction formed in the shape of the boat. Fiber-reinforced plastic is then applied to both the inside and the outside of the core material. The core material used in this type of sandwich construction is in the form of boards of various sizes. When the boards are fitted
10 together, gaps are left between them. In order to obtain a continuous interaction of forces in the sandwich construction, these gaps are filled with a material that joins the edges of the boards together. Up to now, this has been done using a putty compound with a density of ca. 0.6-1.5 kg/dm³. Cellular plastic material usually has a density of between 0.045 to 0.25 kg/dm³. Using a putty compound increases the weight of the construction, which is not desirable, and results in
15 discontinuities in the core material which may have a negative affect on the strength of the sandwich construction in cases e.g. of impact or when the structure is overloaded. Other negative affects are the occurrence of thermal bridges and acoustic transmission.

Normally, the joints, the dimensions of which are shown in fig. 1, are filled by injecting the putty compound. This method has been shown to result in incompletely filled joints, which
20 also weakens the sandwich construction.

Example of an alternative method in accordance with the present invention

The filler material is first prepared by pressing together strips (2) of cellular plastic material under elevated temperature, see fig. 2, so that their thickness is reduced to the thickness required by the method, e.g. 30% of their original thickness, see fig. 3. By allowing the compressed strips to cool before the pressure is removed, the strips will retain their reduced thickness even after the pressure has been removed. A film of moisture-cured hot melt adhesive (4) is applied to the filler material, either during compression or afterwards. The filler material with adhesive coating
30 is inserted into the joint area (1), see fig. 4. By heating the strips of filler material to approx. 70°C, the filler material softens and expands because of internal excess pressure, until the joint area is filled. When heating the filler material and the adhesive, the adhesive melts, and because the filler material expands, it presses the adhesive against the base material so that a bond is formed between the filler material and the base material (5), see fig. 5. After cooling, the filler
35 material hardens and regains its original properties. With the hardening of the filler material, further expansion is prevented, which ensures that the joint remains stable. The adhesive is cured through the humidity of the air.

In order to obtain a joint with load-bearing properties such as good tensile and compression strength as well as shear strength, the method must satisfy the following
40 requirements:

1. The filler material must meet set strength requirements.
2. The adhesive must meet set strength requirements.
- 45 3. The bond between the filler material and the base material must meet the same requirements as are set on the components which make up the joint, i.e. the filler material, the hot melt adhesive, and the base material.

In order for the last requirement to be met, the filler material must fill the joint area completely, i.e. the filler material must expand evenly and completely along the whole of the joint. Also, the hot melt adhesive must melt completely during the time that the filler material is exerting the necessary pressure on the adhesive. This means that the heat must be applied in such way that the above requirements can be met. The present invention offers a solution to the problem of forming an essentially load-bearing joint in e.g. sandwich constructions.

The present invention offers a method which allows bonding at relatively low temperatures, e.g. at 60°C, and where the filler material, when expanded, regains its original form. Thus the size of the filler strips can be predetermined. Expansion through chemical foaming, on the other hand, is always uncontrolled.

In the present invention, rigid cellular plastic material with closed cells is used. This is a prerequisite for expansion to occur as well as for ensuring sufficient rigidity and strength of the finished joint.

15 EXAMPLE OF PROCEDURE

Preparing the filler material

Strips of filler material, in the dimensions desired, are sawn, or by some other means cut out, from the base material, e.g. PVC cellular plastic. In order to achieve sufficient pressure on the adhesive, the strips of filler material, before compression, should be somewhat thicker than the joint area they are to be inserted into. The thicker are the strips of filler material, the greater will be the pressure on the adhesive when the filler material expands during the heating stage. But if the filler material is to regain maximum strength, the filler material must expand as completely as possible, so that the cells in the material will have maximum spherical form and thus give the desired strength.

The filler material is then placed in a heating unit that has been heated to approx. 80°C. After heating, the filler material is then placed in a press where it is compressed to approx. 20%-50% of its original thickness. During this operation, the filler material can be coated with a film of hot melt adhesive which, because of the pressure and the heat from the filler material, will adhere to the filler material in the designed manner. If the film of hot melt adhesive is prepared a few minutes before it is applied (just before the press stage), some hot melt adhesives will still adhere to the filler material even after they have stiffened.

The hot melt adhesive can also be applied to the filler material at a later stage. The simplest way is to fold the adhesive film around the strip of filler material before it is inserted into the joint area. The adhesive film may even consist of two separate layers applied one to each side of the filler material.

Heating by means of microwaves

The compressed strips of filler material are inserted into the joint area and are heated by means of electromagnetic radiation, e.g. microwaves. The hot melt adhesive, consisting e.g. of polyurethane, is affected by the electromagnetic field and thus becomes heated. The filler material is indirectly heated when the adhesive is heated. Since the electromagnetic field is formed in such a way that it is homogeneous in the area of the joint, an immediate and uniform heating of the hot melt adhesive takes place. The indirect heating of the filler material is, thereby, also uniform. Expansion is uniform and an evenly distributed pressure on the adhesive is obtained.

In most cases where sandwich constructions are used in ships and boats, PVC is used as core material. PVC is affected hardly at all by the electromagnetic field and thus will not become

heated. The same applies to the filler material which, with advantage, can be made of the same material as the core material. The only heating that takes place comes from the hot melt adhesive which comprises a very small volume of the whole assembly. This heat is enough, however, to cause the filler material to expand to the desired extent. The filler material in compressed state
5 is so thin, and contains so little mass in relation to the width of the joint area, that it becomes heated without difficulty.

The finishing stage of the process is limited to removing excess hot melt adhesive which has been pressed out during the expansion stage. What remains, after the hardening process is complete, is a well-filled, load-bearing joint.

10 Other cellular plastics than PVC can be used as filler material, or as core material, e.g. cellular plastic of PUR, PS, etc. Most cellular plastics are little affected by electromagnetic radiation, and thus the advantages of the heating procedure are retained, i.e. unnecessary heating of the base material is avoided. Note also that although polyurethane in the form of hot melt adhesive becomes heated very quickly, a cellular plastic of the same material becomes hardly
15 heated at all by electromagnetic radiation during the same period of time. After a sufficiently long period of time, however, most cellular plastic materials will eventually become heated through e.g. microwave radiation. For e.g. PVC, however, this occurs in an unstable manner, which causes an uncontrolled temperature rise locally in the material. This is not desirable, and thus indirect heating is more advantageous.

20 It is also possible, during the chemical process used in the production of cellular plastic materials, to use additives which are affected by electromagnetic radiation. Examples of such additives are powdered coal and powdered steel. This makes the material more expensive, however, and also creates problems during foaming. Thus, it is difficult to obtain cellular plastic material with sufficiently good properties.

25 Heating with hot air

When building ships or boats with sandwich construction, heat can be applied by means of a hot air device, electric blankets, etc. When heating by means of hot air, care must be taken to
30 regulate the temperature so that the material of which the construction is comprised will not be damaged. This is particularly important in large constructions where the heat is to be applied for relatively long periods of time, e.g. for a few hours at a time.

35 PATENT CLAIMS

1. A method for forming a load-bearing joint, *characterized by* the use of a cellular plastic material as filler material (2); by the compression of the cellular plastic to a form that is stable at room temperature(3); by applying adhesive (4) to the bonding surfaces of at least the filler material, fig. 4; by inserting the filler material, (3) and (4), into the joint area (1), fig. 4; and by causing the filler material to expand by means of heating so that the fusion surfaces of the filler material are pressed against the restricting surfaces of the joint area, fig. 5, after which the filler material is allowed to cool.
- 45 2. A method as claimed in claim 1, *characterized by* the use of an adhesive (4) which is a hot melt adhesive or a hot melt adhesive with setting agent, said adhesive being made to melt during the heating phase of the filler material.
3. A method as claimed in claim 1, *characterized by* the use of a one or two-component adhesive (4) in liquid form.
4. A method as claimed in claim 1, *characterized by* the use of a one or two-component
5 adhesive (4) in liquid form, or the use of a hot melt adhesive or a hot melt adhesive with setting agent, said adhesive being heated by means of electromagnetic radiation.
5. A filler material used to form a load-bearing joint, *characterized by* a strip of compressed cellular plastic (3) which expands under heat, and which has been coated on opposite sides with
10 an adhesive film (4), fig. 4.

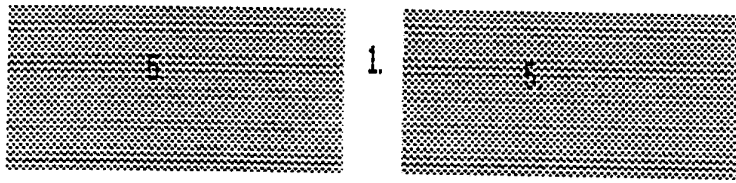


fig. 1



fig. 2



fig. 3

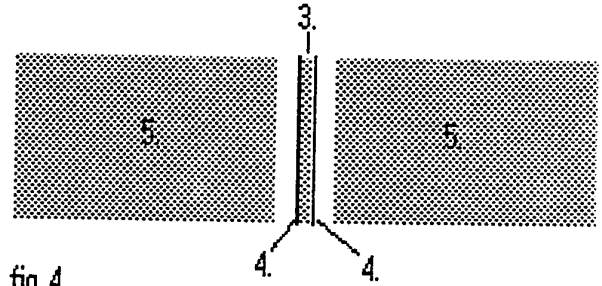


fig. 4

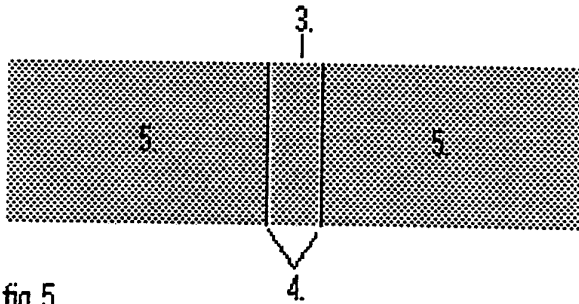


fig. 5

INTERNATIONAL SEARCH REPORT

International Application No PCT/SE 92/00076

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) ⁶ According to International Patent Classification (IPC) or to both National Classification and IPC IPC5: B 29 C 65/02, E 04 B 1/682																	
II. FIELDS SEARCHED Minimum Documentation Searched⁷ <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 20%; border: 1px solid black; text-align: left;">Classification System</th> <th style="border: 1px solid black; text-align: left;">Classification Symbols</th> </tr> <tr> <td style="border: 1px solid black; height: 40px; vertical-align: bottom;">IPC5</td> <td style="border: 1px solid black; vertical-align: bottom;">B 29 C; E 04 B</td> </tr> </table> Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in Fields Searched⁸ SE,DK,FI,NO classes as above			Classification System	Classification Symbols	IPC5	B 29 C; E 04 B											
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III. DOCUMENTS CONSIDERED TO BE RELEVANT⁹ <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 10%; border: 1px solid black;">Category *</th> <th style="border: 1px solid black;">Citation of Document,¹¹ with indication, where appropriate, of the relevant passages¹²</th> <th style="width: 10%; border: 1px solid black;">Relevant to Claim No.¹³</th> </tr> </thead> <tbody> <tr> <td style="border: 1px solid black; text-align: center;">A</td> <td style="border: 1px solid black;">US, A, 3806566 (RUBENS) 23 April 1974, see abstract; figure 4 --</td> <td style="border: 1px solid black; text-align: center;">1-5</td> </tr> <tr> <td style="border: 1px solid black; text-align: center;">A</td> <td style="border: 1px solid black;">US, A, 4647716 (AKIYAMA ET AL) 3 March 1987, see column 2, line 65 - column 3, line 48 --</td> <td style="border: 1px solid black; text-align: center;">1-5</td> </tr> <tr> <td style="border: 1px solid black; text-align: center;">A</td> <td style="border: 1px solid black;">US, A, 4898630 (KITOH ET AL) 6 February 1990, see column 8, line 51 - column 9, line 50 --</td> <td style="border: 1px solid black; text-align: center;">1-5</td> </tr> <tr> <td style="border: 1px solid black; text-align: center;">A</td> <td style="border: 1px solid black;">DE, A, 1784467 (N.V. ASPHALT-BITUMEN-ONDERNEMING ASBITON) 11 November 1971, see page 1, line 1 - page 2, line 9 --</td> <td style="border: 1px solid black; text-align: center;">1-5</td> </tr> </tbody> </table>			Category *	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³	A	US, A, 3806566 (RUBENS) 23 April 1974, see abstract; figure 4 --	1-5	A	US, A, 4647716 (AKIYAMA ET AL) 3 March 1987, see column 2, line 65 - column 3, line 48 --	1-5	A	US, A, 4898630 (KITOH ET AL) 6 February 1990, see column 8, line 51 - column 9, line 50 --	1-5	A	DE, A, 1784467 (N.V. ASPHALT-BITUMEN-ONDERNEMING ASBITON) 11 November 1971, see page 1, line 1 - page 2, line 9 --	1-5
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* Special categories of cited documents:¹⁰ "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step "Y" document of particular relevance, the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art. "&" document member of the same patent family																	
IV. CERTIFICATION <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; border: 1px solid black; padding: 5px;"> Date of the Actual Completion of the International Search 13th May 1992 </td> <td style="width: 50%; border: 1px solid black; padding: 5px;"> Date of Mailing of this International Search Report 1992 -05- 19 </td> </tr> <tr> <td style="border: 1px solid black; padding: 5px;"> International Searching Authority SWEDISH PATENT OFFICE </td> <td style="border: 1px solid black; padding: 5px;"> Signature of Authorized Officer <i>Kristina Sköld</i> Kristina Sköld </td> </tr> </table>			Date of the Actual Completion of the International Search 13th May 1992	Date of Mailing of this International Search Report 1992 -05- 19	International Searching Authority SWEDISH PATENT OFFICE	Signature of Authorized Officer <i>Kristina Sköld</i> Kristina Sköld											
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III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
A	DE, A, 1963267 (HABER - SUHNER AG KABEL-, KAUTSCHUK, KUNSTSTOFFWERKE) 30 July 1970, see figures 1,2; claim 1 -- -----	1-5

**ANNEX TO THE INTERNATIONAL SEARCH REPORT
ON INTERNATIONAL PATENT APPLICATION NO.PCT/SE 92/00076**

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
The members are as contained in the Swedish Patent Office EDP file on **28/03/92**
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A- 3806566	74-04-23	US-A- 3853684	74-12-10
		US-A- 3616172	71-10-26
US-A- 4647716	87-03-03	DE-U- 8531221	86-05-07
		EP-A-B- 0182199	86-05-28
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		JP-A- 1135965	89-05-29
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		BE-A- 719585	69-02-17
		CH-A- 482137	69-11-30
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DE-A- 1963267	70-07-30	CH-A- 503852	71-02-28
		FR-A- 2026947	70-09-25