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(54) **Electrically insulating rail joint and method to manufacture such a rail joint**

(57) The invention relates to an electrically insulating rail joint for isolating two successive rails or rail portions (1,2) with an insulating element (8) between the end faces of the rails or rail portions, wherein the rails or rail portions are connected by connecting means (6), and wherein a slot (13) and wedge (14) are provided to pre-tension the insulating element.

The invention also relates to a method to produce such a rail joint and to a rail part comprising the rail joint according to the invention

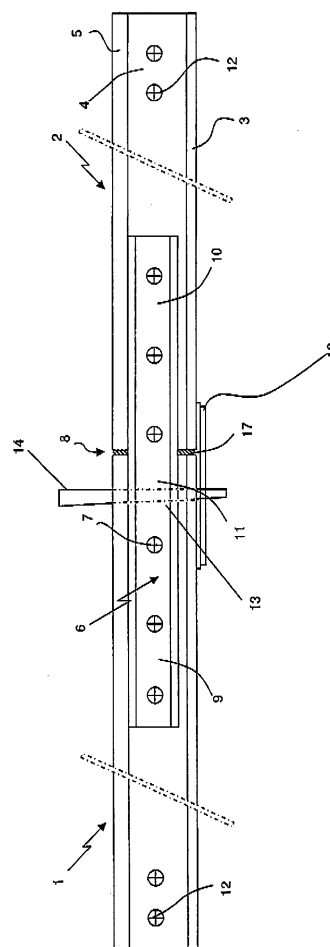


Fig 1

EP 2 206 830 A1

Description

[0001] Electrically insulating rail joint for electrically insulating two successive rails or rail portions from each other wherein the successive rails or rail portions are connected by connecting means and wherein an electrically insulating element is clamped between the end faces of the rails or rail portions.

[0002] These rail joints are used to subdivide railways in consecutive sections electrically insulated from one another to be able to use these sections in signalling, security and controlling systems, such as for instance automatically controlled guarded level crossings and automatic train control. The insulating element is clamped between the end faces of the rails or rail portions to prevent that the insulating element can be moved from the original position under the load of passing trains. If the insulating element gets out of line with the top of the rail-head the rail is bound to wear out faster at that location which sooner or later will result in a shortage between the successive rails or rail portions.

[0003] The clamping of the insulating element is also necessary to meet tensional forces that may occur in the rail because of lower temperatures during the night or in winter time. This is especially important if the insulating comprises or consists of a ceramic plate since this material is not suitable at all to receive tensional forces. Preferably a ceramic material is used in an insulating element because of its hardness and abrasion resistance.

[0004] With the insulating rail joint known from WO2008/077617 the insulating element is clamped between the end faces of successive rails or rail portions by first connecting the successive rails or rail portions by means of connecting means such as fishplates, creating a large enough gap between the end faces by exerting sufficiently large opposite forces on the rail and connecting means, after which the insulating element is inserted between the end faces of the rails or rail portions and the opposite forces acting on the rails are removed. To this end a heavy and complicated apparatus is needed to be able to exert sufficient force to get a sufficiently large gap between the end faces. Moreover, the rail and connecting means have to be pre-tensioned to a larger extent than only needed for the clamping of the insulating element.

[0005] It is an object of the present invention to provide an electrically insulating rail joint in which the insulating element can be clamped between the end faces of the rails in an easy manner.

[0006] It is another object of the present invention to provide a method to easily and at low costs manufacture an insulating rail joint wherein an insulating element is clamped between the end faces of the rails.

[0007] It is another object of the present invention to provide a railway part provided with an insulating rail joint as a prefabricated unit.

[0008] According to a first aspect of the invention one or more of the above objects is realized by providing an electrically insulating rail joint for electrically insulating

two successive rails or rail portions from each other wherein the successive rails or rail portions are connected by connecting means and wherein an electrically insulating element is clamped between the end faces of the rails or rail portions, and wherein the connecting means connect to successive end portions of the rails or rail portions wherein for at least one end portion the connecting means connect to the rail or rail portion at a distance from the end face therewith providing a free part of the end portion adjacent the corresponding end face, and in that means are provided to exert a compressive force on the insulating element which means act on the insulating element through a free part of at least one end portion of a rail or rail portion adjacent to an end face.

[0009] According to a further aspect it is provided that the means to exert a compressive force on the insulating element comprise a slot in the free part of an end portion at a distance from the corresponding end face of a rail or rail portion and a wedge fitting at least partly in the slot. With this configuration of the insulating rail joint the insulating element is brought in between the end faces of the rails or rail portions after which sufficient clamping force is brought on to the insulating element by driving the wedge further in the slot. In this manner the clamping force can be applied easily without the need of having first to pre-tension rails and connecting means.

[0010] The slot in the end portion of the rails or rail portions is preferably positioned transverse to the length direction of the rail. According to a further aspect of the invention the slot cuts through the rail in at least one direction which means that the slot cuts in at least one direction completely through a rail and could therewith leave at one or more locations a connection between the rail parts at both sides of the slot. For example the slot could stop just above the foot of the rail or the slot could cut through the head portion and the feet leaving a connection at the outer sides of the foot. This embodiment would help to hold the part of the rail between the slot and the end face of the rail or rail portion in place during the assembly of the rail joint but would easily deform when driving the wedge in the slot to its final position.

[0011] According to a further embodiment the slot is realized by cutting through the total cross-section of the rail. Although, this slot results in a separate piece of rail which needs positioning and support during the manufacturing of the rail joint and especially when driving the wedge in the slot till the right pretension of the insulating member is realized, it is the easiest way to make a slot. By positioning the rails or rail portions and the separate piece it can easily be achieved that the slot gets a pre-determined width.

[0012] The wedge used in the slot has a width smaller than the distance between the connecting means provided at both sides of the rail or rail portion at least at the location of the connecting means. The distance between the connecting means is at its smallest in the intermediate section of the rail, the neck of the rail, between the head part and foot part of the rail and the portion of the wedge

that will finally be positioned in between the connecting means has to have a width smaller than that distance. The width has also to be smaller to avoid electrical contact between the connecting means and the wedge and therewith with the rail. The portion of the wedge that will not come between the connecting means can have a larger width. Moreover, the upper section may have a width and shape that at least partly corresponds to the shape of the rail head.

[0013] The material of the wedge is the same as that of the rail or is chosen such that the characteristics thereof are similar to or corresponds as much as possible to those of the rail head to avoid uneven wear of the rail head and wedge.

[0014] According to another aspect of the invention the sides of the wedge that will be in contact with the opposite sides of the slot are at an angle with respect to each other with a ratio between 1:300 to 1:700. Preferably the ratio is in the range of 1:400 to 1:600 and even more preferably 1:500. With this angle of the wedge the vertical alignment of the rail at the location of the slot and wedge will result in a peaked alignment which is preferred under the recurrent dynamic load conditions.

[0015] If the shape of the wedge is such that the slot is not completely filled the open part of at least the head part of the rail is according to a further aspect of the invention filled up. This can be done for example by welding or by welding material in the open part of the slot and if necessary rework the weld so that it is in line with the profile of the rail.

[0016] If necessary the stiffness of the rail joint may further be improved by gluing a steel plate at the bottom of the rail at the location of the joint.

[0017] The electrically insulating element in the rail joint can be any known electrically insulating rail joint. However, an electrically insulating element comprising a ceramic plate is preferred and an electrically insulating element in the form of only a ceramic plate is even more preferred. By only using a ceramic plate as an electrically insulating element it is possible to exert a compressive force on the insulating element that is sufficiently large to take up contraction forces in the rails due to temperature changes. Since the compression strength of ceramic material is better than 300MPa and for most ceramic material even far better than that, the insulating element according to this embodiment has a compression strength that is more than sufficient to withstand the compressive force exerted on it. The compression strength is also more than sufficient to take up any additional compressive load due to expansion of the rails. Furthermore, ceramic material has a low linear extension coefficient, which is typically lower than $13 \cdot 10^{-6} / ^\circ\text{C}$ and for a number of commercially available ceramic materials will be in the range of $7 \cdot 10^{-6}$ and $13 \cdot 10^{-6} / ^\circ\text{C}$. Because of this low linear extension coefficient changes in temperature will have minimal effect on the compressive force exerted on the insulating sheet.

[0018] Commercially available ceramic materials that

are suitable to be used as insulating element in the rail joint according to the invention are for instance Zirconia or Alumina and also glass ceramic material, such as Macor (registered trademark of Corning Inc.). These glass ceramics and more in particular Macor have a hardness of about 400 Wickers corresponding to the hardness of rails which will ensure equal abrasion of rail and rail joint. The hardness of Zirconia is about 1100 Vickers and that of Alumina 1500 Vickers.

[0019] According to a further embodiment it is provided that the electrically insulating element has a thickness between 1 and 20 mm, preferably a thickness of at least 3 mm, and preferably a thickness of at most 10 mm. With such a thickness of the electrically insulating element the rail ends are kept at sufficient distance to prevent short circuiting of the rail joint by for instance accumulation of abrasion powder or the like.

[0020] The specific electrical resistance of the above ceramic materials lies in a range of $10^6 - 10^{15} \Omega\text{m}$, which values are far higher than the required minimum value for the specific electrical resistance of the insulating sheet for the rail joint. The electrical resistance for a rail joint in for instance the well known UIC60 rail with one insulating sheet of for instance Zirconia with a thickness of 1 mm would be about $1 \times 10^6 \Omega$. With a glass ceramic material as for instance Macor with a thickness of 3 mm the electrical resistance of the rail joint in the same rail would be about $50 \times 10^{12} \Omega$. These resistance values are much higher than the required minimal values of the electrical resistance of the rail joint. Even with a specific electrical resistance of $20 \Omega\text{m}$ of the insulating element the resulting resistance of the rail joint is such that the rail joint will still function properly. However the resistance of the rail joint is preferably considerable higher to prevent that due to contamination the rail joint would need to be serviced more often or that the rail joint has to be replaced after a relatively short time.

[0021] Preferably the form of the electrically insulating sheet follows the profile of at least the head part of the rails, the head part of the rail being the part that comes into direct contact with the wheels of the train. The remaining part of the profile of the rails does not have to be followed exactly, as long as the insulating sheet completely covers the end faces of the rails or rail portions. This gives optimal insulation while allowing an outer shape of the insulating sheet that can be manufactured easily.

[0022] According to a further embodiment the electrically insulating element has a tapered shape in order to get an elevated or peaked vertical alignment, which is preferred under dynamic load conditions. This configuration has the advantage that the rail does not have to be supported at the location of the insulating element during use.

[0023] The invention also provides a method for manufacturing an electrically insulating rail joint in which a compressive force is exerted on an electrically insulating element placed between end faces of two successive

rails or rail portions, the method comprising the steps of:

- providing a slot in a free part of an end portion of a rail or rail portion at a distance from the corresponding end face of that end portion,
- positioning the end faces of successive rails or rail portions at a distance from each other creating a gap between the end faces,
- connecting the end portions of successive rails or rail portions at both sides of the gap by means of connecting means, wherein for at least one end portion the connecting means are connected to the rail or rail portion at a distance from the end face therewith providing a free part of the end portion adjacent the corresponding end face,
- inserting the electrically insulating element in the gap between the end faces of the successive rails or rail portions,
- exerting a compressive force on the insulating element by driving a wedge in the slot provided in a free part of an end portion of a rail or rail portion.

[0024] According to a further embodiment the connecting means connect the successive rail portions such that the end faces, between which the gap for the insulating element is located, are at an angle. This angle corresponds to the tapered shape of the insulating element wherein the opposite sides of the insulating element are at an angle with a ratio between 1:300 to 1:700. Preferably the ratio is in the range of 1:400 to 1:600 and even more preferably about 1:500. With this angle the gap with the insulating element will have an elevated vertical alignment or peaked alignment which is preferred under dynamic load conditions.

[0025] The connecting means comprise fish plates at both sides of the end portions of the rails or rail portions which are at least bolted to each other to establish a connection such that the fish plates are electrically insulated from at least one end portion.

[0026] After positioning and aligning the rail portions with respect to each other, inserting the insulating element and mounting the connection means glue is applied between part of the fish plates and the end portions of the rails or rail portions. The glue is applied between outer portions of the fish plates and the rails or rail portions leaving an intermediate portion of the fish plates clear. The slot for the wedge is located at this intermediate portion. In order to have maximal adherence of the glue to the different parts of the connecting means and the rails or rail portions the surfaces thereof are roughened prior to the application of the glue.

[0027] After the glue has cured the bolts of the connection means are tightened and subsequently while the rail joint is sufficiently supported the wedge is put in the slot and driven into the slot till the right compressive force on the insulating element is attained.

[0028] The wedge has at least along part of the length thereof a width smaller than the distance between the

connecting means at the neck portion of the rail. Since the angle between the sides of the wedge is relatively small the wedge has a length greater than the largest distance between the head and foot of the rail and for that reason the width of the wedge over the total length thereof is preferably taken smaller than the distance between the connecting means at the neck portion of the rail. With this feature the length of the wedge will be taken such that it will always be long enough to be able to get the wanted compressive force acting on the insulating element. At the same time this will also mean that the wedge in its final position will extend from the rail at least one side and consequently that the rail has to be reworked at that location to get at least the right profile for the rail. For the head part of the rail this will in most cases mean that a protruding part of the wedge has to be cut off. Any remaining gap or open space is at least partly filled up so that at least the head part forms a continuous transition at the location of the wedge.

[0029] After reworking the rail at the location of the wedge at least as far as necessary the space between the intermediate portion of the connecting means and the end portions of the rail or rail portions is filled with glue.

[0030] The method can be applied at the location in the track where the rail joint is to be provided, however according to a further elaboration of the invention a railway part is provided comprising two rail portions with a rail joint according to the invention between the rail portions. Such a railway part is mounted as a prefabricated unit in an existing railway by removing a corresponding part from the railway and replacing it by the railway part according to the invention. The railway part is connected to the existing railway by means of for instance welding techniques as commonly used in railway construction and maintenance. The advantage of using a prefabricated railway part is that the rail joint can be mounted between rail portions under the best possible conditions in a workshop ensuring an optimal fit of the rail joint between the rail portions. A further advantage of prefabricating the railway part is that it is possible to manufacture the railway part in serial or batch production therewith lowering the costs per unit.

[0031] The railway parts according to the invention may be inserted in an existing railway by taking out a corresponding length of the original railway and replacing it by the railway part. The railway part is preferably connected to the existing rail such as to form a continuous welded rails. According a preferred embodiment railway parts are placed in the railway such that the rail joint in the railway parts is positioned between two sleepers of the railway. Since the space required for the fastening and/or positioning means with which a rail is mounted on the sleepers will leave only very little space for the connecting means for the rail joint, it is preferred to have the rail joint between sleepers.

[0032] The rail joint and railway part according the invention are further elucidated on hand of the example given in the drawing.

[0033] The figure shows a side view of two rail portions 1,2 with a foot, neck and head portion 3,4,5 respectively. The rail portions 1,2 are connected by means of fish plates 6 on both sides of the rail portions 1,2 and bolts 7. Between the end faces of the rail portions 1,2 a gap 8 is provided for the insulating element 17, the gap having a width of 3-10 mm, for instance 6 mm. Before inserting ceramic element 17 in gap 8 glue will preferably be applied to the end faces of the rail portions 1,2. The glue used to this end has the same mechanical properties as the glue used to glue the outer portions 9,10 to the rail portions 1,2.

[0034] The fish plates 6 and rail portions 1,2 are first provided with corresponding boreholes after which the bolts 7 are put through fishplates 6 and rail portions 1,2. Before tightening bolts 7 the fish plates 6 are glued to the rail portions 1,2. The glue layer has a thickness of for instance 3 mm, for which plastic shims of the same thickness are used between the rail portions 1,2 and the fish plates 6. Glue is applied at the outer portions 9,10 of the fish plates 6, which are the portions provided with bolts 7. The intermediate area 11 between the outer portions 9,10 is not glued at this stage of the manufacturing of the rail joint. After hardening of the glue, the bolts are pre-stressed by tightening the bolts.

[0035] To guarantee good adhesion of the glue to the portions of the rails 1,2 and the fish plates 6, these portions are roughened by for instance grid blasting. Immediately afterwards these portions are preferably coated with a thin layer of glue in order to prevent oxidation.

[0036] Between the gap 8 for the insulating element 17 and the first bolt 7 of the fish plates a slot 13 is provided in rail portion 1 in which a wedge 14 is inserted. The slot is preferably formed by cutting the rail to get a resulting slot with a width in the range of 10-30 mm and preferably of about 20 mm. The wedge has a tapered shape with an inclination of 1:500 to 1:700 and a width corresponding to that of the slot as seen in the length direction of the rails.

[0037] After curing of the glue between fish plates 6 and rail portions 1,2 and tightening of bolts 7 wedge 14 is driven further in the slot till a predetermined compressive load on the insulating element 17 is attained. Preferably the compressive load on the insulating element is brought to a value in the range of 500-2000kN, more preferably in the range of 800-1400kN and even more preferably in the range of 900-1100 kN.

[0038] After driving the wedge 14 in the slot 13 to get a compressive load on the insulating element 17 the wedge 14 as far as it is protruding from the rail is cut off. The gap remaining in the head of the rail is filled for instance by welding or by welding a filler element in the gap, after which the head is grinded to a smooth surface.

[0039] Finally the space between the fish plates 6, rail portions 1,2, wedge 14 and insulating element 17 is filled with glue, and, if necessary, a steel plate 18 is glued to the flat bottom of rail portions 1,2 covering both the slot 13 with wedge 14 and gap 8 with insulating element 17. In the figure steel plate 18 is shown without the wedge

14 being cut off, it will however be clear that steel plate 18 will be glued to the rail only after the wedge has been cut off. The complete wedge 14 is shown in the figure for clarity's sake.

[0040] For the skilled person it will be evident that the invention is not limited to the embodiments described above, rather numerous alternative embodiments may be envisaged without departing from the scope of the present invention.

Claims

1. Electrically insulating rail joint for electrically insulating two successive rails or rail portions from each other wherein the successive rails or rail portions are connected by connecting means and wherein an electrically insulating element is clamped between the end faces of the rails or rail portions,
characterized in that,
the connecting means connect to successive end portions of the rails or rail portions wherein for at least one end portion the connecting means connect to the rail or rail portion at a distance from the end face therewith providing a free part of the end portion adjacent the corresponding end face, and
in that means are provided to exert a compressive force on the insulating element which means act on the insulating element through a free part of at least one end portion of a rail or rail portion adjacent to an end face.
2. Rail joint according to claim 1, wherein the means to exert a compressive force on the insulating element comprise a slot in the free part of an end portion at a distance from the corresponding end face of a rail or rail portion and a wedge fitting at least partly in the slot.
3. Rail joint according to claim 2, wherein the slot is positioned transverse to the length direction of the rail.
4. Rail joint according to claim 3, wherein the slot cuts through the rail in at least one direction.
5. Rail joint according to claim 3 or 4, wherein the width of the wedge is smaller than the distance between the connecting means provided at both sides of the rail or rail portion at least at the location of the connecting means.
6. Rail joint according to one or more of claims 2-5, wherein the sides of the wedge that will be in contact with the opposite sides of the slot are at an angle with respect to each other with a ratio between 1:300 to 1:700.

7. Rail joint according to one or more of claims 1-6, wherein the electrically insulating element comprises a ceramic plate.
8. Method for manufacturing an electrically insulating rail joint in which a compressive force is exerted on an electrically insulating element placed between end faces of two successive rails or rail portions, the method comprising the steps of:
- providing a slot in a free part of an end portion, of a rail or rail portion at a distance from the corresponding end face of that end portion,
 - positioning the end faces of successive rails or rail portions at a distance from each other creating a gap between the end faces,
 - connecting the end portions of successive rails or rail portions at both sides of the gap by means of connecting means, wherein for at least one end portion the connecting means are connected to the rail or rail portion at a distance from the end face therewith providing a free part of the end portion adjacent the corresponding end face,
 - inserting the electrically insulating element in the gap between the end faces of the successive rails or rail portions,
 - exerting a compressive force on the insulating element by driving a wedge in the slot provided in a free part of an end portion of a rail or rail portion.
9. Method according to claim 8, wherein the connecting means connect the successive rail portions such that the end faces creating a gap for the insulating element are at an angle.
10. Method according to claim 8 or 9, wherein the connecting means comprise fish plates at both sides of the end portions of the rails or rail portions which are at least bolted to each other to establish a connection such that the fish plates are electrically insulated from at least one end portion.
11. Method according to claim 10, wherein glue is applied between part of the fish plates and the end portions of the rails or rail portions before the wedge is driven in the slot.
12. Method according to claim 11, wherein the glue is applied between outer portions of the fish plates and the rails or rail portions leaving an intermediate portion of the fish plates clear.
13. Method according to one or more of claims 8-12, wherein after driving the wedge into the slot to apply a compressive force on the insulating element the part of the slot still remaining open is at least partly filled up.
14. Method according to claim 12 or 13, wherein the space between the intermediate portion of the connecting means and the end portions of the rail or rail portions is filled with glue.
15. Railway part comprising two rail portions with a rail joint according to one or more of claims 1-7 between the rail portions and manufactured according to one or more of claims 8-14.

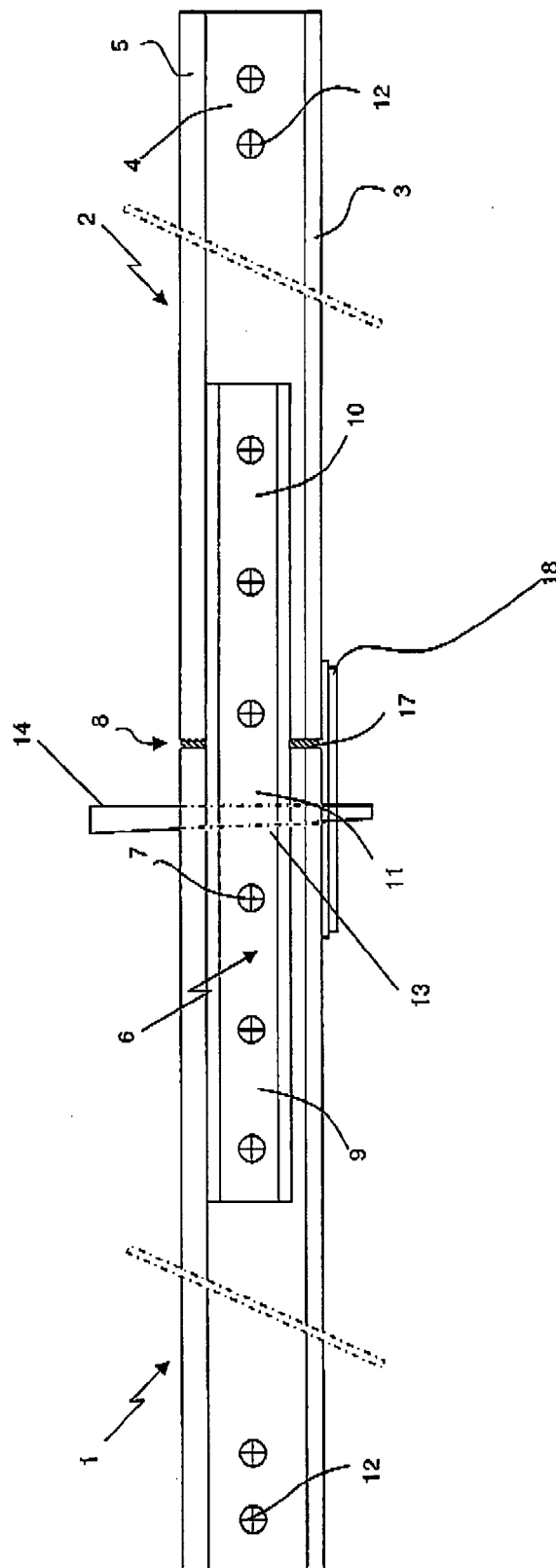


Fig 1



EUROPEAN SEARCH REPORT

Application Number
EP 09 00 0342

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
D,A	WO 2008/077617 A (CORUS TECHNOLOGY BV [NL]; MOVARES NEDERLAND B V [NL]; SINNEMA SIDO [NL] 3 July 2008 (2008-07-03) * the whole document *	1	INV. E01B11/54
A	JP 09 143904 A (SEKISUI CHEMICAL CO LTD) 3 June 1997 (1997-06-03) * abstract; figures *	1	
			TECHNICAL FIELDS SEARCHED (IPC)
			E01B
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 6 July 2009	Examiner Movadat, Robin
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 09 00 0342

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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06-07-2009

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2008077617 A	03-07-2008	NONE	
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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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