The invention relates to a trenching machine comprising a saw blade assembly. Fig. 7

Fig. 7

Abstract: The present invention relates to a saw blade assembly for a machine arranged for sawing trenches in an area; said area comprising a first layer L1 and a second layer L2, said first layer L1 being a hard surface layer, such as asphalt or concrete, and said second layer L2 being a bearing layer for said first layer L1 and being positioned below said first layer L1, wherein said saw blade assembly is arranged to saw through said first layer L1 and into said second layer L2; said saw blade assembly comprising: at least two first type of saw blades having a working surface, at their periphery, comprising at least one segment of a kind of blade arranged for sawing, at least one second type of saw blade having a working surface, at their periphery, comprising at least one hard material teeth arranged for digging up debris and transporting away the debris from said trench; wherein said first type of saw blades and said second type of saw blades are complementary to each other and are alternately arranged to form said saw blade assembly, and wherein the outermost saw blades of said saw blade assembly are of said first type of saw blades. The invention also relates to a trenching machine comprising such a saw blade assembly.
A SAWBLADE ASSEMBLY FOR TRENCHING MACHINES

Technical field
The present invention relates to a saw blade assembly for trenching machines. The invention relates in particular to a saw blade assembly according to claim 1. The invention also relates to a trenching machine comprising such a saw blade assembly.

Background
The need for making trenches in streets, roads and sidewalks is continuously increasing, among others because of the increasing need for installations of broad band based on fiber optical cables in living areas. So called Micro Trenching is expected to become the dominating method for building Fiber-To-The-Home (FTTH) in areas with Single-Family-Units (SFU). In Sweden around 400 000 Single Family Units (SFUs) will be connected over fiber in the coming 5-10 years. The world market is enormous and can be estimated to around 100 - 500 times the Swedish market. E.g. between 40 million and 200 million SFUs around the world will be connected over fiber in the coming 20 years.

Conventional methods, such as e.g. digging a trench using an excavator, involve high costs, mainly because of the cost for restoring a 20-50 cm wide trench. For this reason new and less costly techniques have been developed over the past 10 years. These techniques are less costly because the width of the trench is made much smaller. One such technique with much lower cost is to saw the trench using a machine having a circular saw blade having diamonds in segments around its periphery. Another such technology is to create the trench using a machine having a circular saw blade having teeth of cemented carbide such as tungsten carbide. Both of these techniques have their advantages and disadvantages. A saw blade having segments with diamonds is expensive to purchase. However it makes very fine cuts regardless of the material in the surface layer and the bearing layer. Such fine cuts make the restoration of the road or sidewalk easy and less costly. A saw blade with teeth made of cemented carbide is less costly to purchase and it sometimes allows for higher forward speed of the sawing machine. However, such a saw blade often produces cuts with cracks and great roughness in the sides of the surface layer. Specially if the bearing layer contains stones larger than the width of the trench, a saw blade with large teeth will make enormous damages when those stones are thrown up to the surface and thereby trashing the sides of the trench. This is why trenches made by saw blades with teeth of cemented carbide often are very expensive to
Summary of the invention

An object of the present invention is to completely or partially solve the problems and disadvantages of prior art.

Another object of the present invention is to provide an assembly of saw blades for making a trench in an area, through a hard surface layer, such as asphalt or concrete and into an underlying bearing layer at a cost, much lower compared to known techniques.

The above mentioned and further objects are achieved by a first aspect of the invention relating to a saw blade assembly for a machine arranged for sawing trenches in an area; said area comprising a first layer L1 and a second layer L2, said first layer L1 being a hard surface layer, such as asphalt or concrete, and said second layer L2 being a bearing layer for said first layer L1 and being positioned below said first layer L1, wherein said saw blade assembly is arranged to saw through said first layer L1 and into said second layer L2; said saw blade assembly comprising:
- at least two first type of saw blades having a working surface, at their periphery, comprising at least one segment of diamonds arranged for sawing,
- at least one second type of saw blade having a working surface, at their periphery, comprising at least one hard material teeth arranged for digging up debris and transporting away the debris from said trench;

wherein said first type of saw blades and said second types of saw blades are complementary to each other and are alternately arranged to form said saw blade assembly, and

wherein the outermost saw blades of said saw blade assembly are of said first type of saw blades.

Different embodiments are defined in the appended dependent claims.

The above mentioned and further objects are achieved by a second aspect of the invention relating to a trenching machine comprising at least one saw blade assembly according to the first aspect.
**Brief description of figures**

Fig. 1 shows schematically a trenching machine 11 (also known as sawing machine), which by the aid of a saw blade assembly 3, with a rotation direction 4, is sawing through a surface layer 1, L1, such as asphalt or concrete and into the underlying bearing layer 2, L2, down to the bottom of the trench 6 (see also Fig. 3 and 4). The trenching machine moves forward with a certain speed in the sawing direction 5 by the aid of wheels 7, one of which is shown in the figure.

Fig. 2 shows the trenching machine further developed to a combined trenching and cable/duct laying machine 8, which, by the aid of a stabilizing device 9, places a number of ducts and/or cables 10 on the bottom of the trench 6.

Fig. 3 shows a cross section of a trench 12 sawn by a trenching machine through a surface layer L1 of asphalt or concrete and into the underlying bearing layer L2.

Fig. 4 shows a cross section of a trench 12 sawn by a trenching machine through a surface layer L1 of asphalt or concrete and into the underlying bearing layer L2, where a number of ducts and/or cables have been placed on the bottom of the trench.

Fig. 5 shows a possible design of one first type of the saw blade for a saw blade assembly according to the invention, the first type of saw blade comprises a steel core blade 13 and a working surface around the periphery 14 of the saw blade comprising segments containing diamonds. The first type of saw blades is arranged for sawing in the area, i.e. not digging.

Fig. 6 shows another possible design of one of the saw blades for a saw blade assembly according to the invention, comprising a steel core blade 15 and a working surface around the periphery 16 of the saw blade comprising segments containing diamonds or alternatively teeth made of hard material. The figure shows an example of pie-shaped cut-outs in the steel core blade in order to reduce weight. The saw blade shown in Fig. 6 may be the saw blade of the first type or the second type, however the saw blade in Fig. 6 should not be one of the two outmost saw blades since debris may fill up the cut-outs thereby reducing performance.

Fig. 7 shows a possible saw blade assembly according to the invention shown in exploding perspective view. The saw blade assembly in Fig. 7 comprises a total of three saw blades.
Fig. 8 shows the cross section marked A-A in Fig. 5 of two possible saw blade assemblies according to the invention, to the left having three saw blades and to the right having five saw blades. Each of the saw blades in respective assembly of saw blades has a steel core blade 19 and a working surface around its periphery with segments containing diamonds 17 or teeth made of hard material 18 depending on the type of saw blade.

**Detailed description**

A saw blade assembly 3 according to the present invention is arranged to be used with a trenching machine 8 or 11 shown in Fig. 1 and 2. With the aid of the present saw blade assembly 3, the trenching machine saws a trench through a hard surface layer L1, such as asphalt or concrete and into the underlying bearing layer L2, normally consisting of gravel, sand and stones in an area.

A further developed trenching machine is a combined sawing and laying machine 8 (shown in Fig. 2), which trenching machine comprises a stabilizing device 9, which during operation, is arranged directly behind said saw blade assembly 3, said stabilizing device 9 stabilizes the sides of said trench and comprises guiding means for guiding at least one duct and/or cable 10 when being installed in said trench 12 directly behind said saw blade assembly.

Each saw blade in said saw blade assembly comprises a steel core blade 13, 15, 19 with attached working surfaces 14, 16 consisting of segments 17 containing diamonds or any future material with the same or greater hardness or alternatively teeth 18 made of hard material, such as hardened steel, cemented carbide or any other hard and wear resistant material. Therefore, the present saw blade assembly comprises at least two first type of saw blades having a working surface, at their periphery, comprising at least one segment of diamonds arranged for sawing in the area. The present saw blade assembly further comprises at least one second type of saw blade having a working surface, at their periphery, comprising at least one hard material teeth arranged for digging and transporting away debris, such as gravel, sand and small stones, from the trench.

A saw blade assembly comprising three saw blades, as shown in Fig. 7 and left side of Fig. 8, is made using saw blades of the first type with segments 17 comprising diamonds as the outermost two saw blades surrounding a saw blade of the second type with teeth 18 made of
hard material.

If one wishes to make a wider trench, more than three saw blades may be assembled together. Then the outermost two saw blades (of the first type) of the assembly shall always have segments 17 with diamonds. The saw blades between the two outermost saw blades shall be arranged with every second blade with segments 17 having diamonds and every second blade with teeth 18 made of hard material. This means that according to the present invention the first type of saw blades and said second types of saw blades are complementary to each other and are alternately arranged to form the saw blade assembly. Further, the outermost saw blades of the saw blade assembly are of the first type of saw blades described. This is shown in Fig. 8 where the outermost saw blades are of the first type having segments with diamonds 17, and wherein the two different types of saw blade are alternately arranged. In the left figure of Fig. 8 the saw blade assembly comprises one saw blade of the second type, and in the right figure of Fig. 8 the saw blade assembly comprises two saw blades of the second type.

The sawed width made by individual saw blades in the saw blade assembly is between 5-60 mm, and preferably 5 - 40 mm for saw blades with teeth made of hard material and 2 - 30 mm or 2.2 - 30 mm from saw blades with segments comprising diamonds.

The space between sawed width from one saw blade and the sawed width from an adjacent saw blade in an saw blade assembly should be larger than -2 mm and less than 10 mm. If the saw blades with segments containing diamonds have larger diameter compared with the saw blades having teeth made of hard material and the segments containing diamonds have larger width than their steel core blade there may be an overlap of the widths of adjacent saw blades.

The dimensions of a saw blade assembly are determined by the sizes and number of ducts/cables to be placed in the trench and by the required installation depth. A suitable total sawing width of a saw blade assembly is larger than 15 mm and less than 100 mm. A suitable diameter of the saw blades containing diamonds is 400 mm - 1200 mm while the diameter of the saw blades with teeth made of hard material is 0 - 200 mm less than the saw blades with segments containing diamonds in one and the same saw blade assembly.

In order to reduce the weight of the saw blade assembly, at least one of the saw blades in the assembly may have core blades with cut-outs (Fig. 6 and 7). These cut-outs may have
different shapes e.g. circular or pie-shaped cut-outs. However, the two outermost saw blades of the first type should not have cut-outs or only minor cut-outs in order to reduce the possibility for the assembly being filled with debris, such as sand, gravel and dirt, according to an embodiment of the invention.

The function of the two different types of saw blades in a saw blade assembly is that saw blades with segments containing diamonds have larger diameter and thereby will lead the way into the trench making very fine cuts in the surface layer and in stones in the bearing layer. The adjacent saw blades with teeth made of hard material and having smaller diameter come afterwards and crushes the material between the fine cuts made by the diamond blades.

Normally the saw blade assembly according to the invention is made to rotate on a common axis powered by an engine. This engine is provided with means to adjust the rotating speed of the saw blade assembly so that the rotating speed can be optimized for a particular saw blade assembly.

However, a further embodiment of trenching machines may give the possibility for having two, three or more independent coaxial axes so that the saw blades may have different rotating speeds and even different rotating direction. Some saw blades may have a common rotating speeds and/or rotating direction depending on the application. Such a machine would provide possibilities to optimize the rotating speed for each type of saw blade.

Therefore, the saw blade assembly is mounted to the trenching machine by means of the common axis or the coaxial axes.

Further, in an embodiment the common axis or the coaxial axes further comprises a cooling system arranged for cooling the saw blade assembly. For example, the common axis or the coaxial axes comprises at least one cooling flange, at least one cooling fan, and/or at least one pipe arranged for providing cooling liquid, such as cooling water. Therefore, the cooling system may further comprises at least one temperature sensor may be arranged for sensing the temperature of the saw blade assembly and controlling the flow and possibly the temperature of the cooling liquid in the cooling system.
A very important factor in respect of cost when building FTTH networks, using a micro trenching technology, is the lifetime of the used saw blade assembly. Because the engine powering the saw blade assembly may have 100 horsepower or more it is understandable that if the friction against the walls/sides of the trench increases, the temperature on the saw blade assembly may increase very rapidly. In a few seconds the temperature may rise so much that the saw blade assembly may be destroyed long before the working surfaces have been worn out. In order to reduce the friction against the sides of the trench in case the trenching machine starts to lean to the left or to the right because of an uneven surface (e.g. on the road or sidewalk) the trenching machine may be equipped with a tilt sensor, based on a plumb line or a gyro or other technology. This tilt sensor controls a servo that automatically keeps the saw blade/saw blade assembly vertical (perpendicular) in relation to the surface when the machine encounters uneven surface conditions, such as when the machine has some of its wheels on the sidewalk and the remaining wheels on the road. Hence, according to an embodiment the trenching machine comprises at least one servo arranged for controlling the saw blade assembly, and at least one tilt sensor arranged for sensing the tilt of said saw blade assembly and further arranged to control the servo so that the saw blade assembly is kept vertical since the working angle of the saw blade assembly should change controlled and slowly to avoid overheating.

The stabilizing device and the saw blade assembly may be arranged to be lowered and elevated together and/or independently one at a time, e.g. during service or transportation or for temporarily reducing the sawing and laying depth. The stabilizing device, with its guiding means for guiding the ducts/cables into the trench in a controlled and ordered way, is during operation arranged directly behind the saw blade assembly at a distance larger than 0 mm and less than 50 mm from the saw blade assembly so that trenching and laying of ducts/cables may be made in a continuous process.

A saw blade assembly according to the invention allows for the possibility to re-use some of the sawed up material, when re-filling the trench after ducts/cables have been installed in the trench. When trenching with a saw blade assembly equipped with diamond segments only, the grain size in the sawed up material will be too small to be re-used for filling the trench. On the other hand, when trenching with a saw blade assembly equipped with teeth made of hard material only, the damages to the sides of the trench often becomes too severe, because of stones larger than the sawing width have been thrown up to the surface. A saw blade assembly
according to the invention overcomes both problems. Thereby it is possible to re-use the sawed up material for re-filling the trench. This is both an environmental friendly and cost efficient.

The bearing layer L2 normally contains grain sizes 4 - 8 mm, 8 - 16 mm, 16 - 32 mm and sometimes even grain sizes up to 60 mm and over. The design of the saw blade assembly will decide maximum grain size in the sawed up material. The distance between two saw blades with segments containing diamonds and thereby the width of the saw blade with teeth made of hard material in between as well as the difference in diameter between the two types of saw blades, will decide the maximum grain size in the sawed up material. Both for cost reason and for not adding too much of zero-fraction to the sawed up material, the width of the saw blades with segments containing diamonds should be made as small as possible.

The trenching machine or the combined trenching and laying machine may be propelled by wheels or caterpillar tracks. In case of wheels propulsion may be arranged on all wheels or only a few of the wheels. The wheels may also be arranged with an anti-spin system to obtain sufficient propulsion if traction is lost on some of the wheels.

The trenching machine or the combined trenching and laying machine may also be equipped with a device that automatically drives the machine forward in an optimal speed for the current sawing conditions, so that the load on the saw blade/saw blade assembly is kept at an optimal level. This may be achieved by a sensor sensing the torque applied from the engine to the saw blade assembly and being arranged to reduce the machine's speed forward if the torque increases, and vice versa. The torque sensor may be designed using strain gauges mounted on the chassis of the trenching machine or from a sensor measuring the Revolutions Per Minute (rpm) of the engine or in any other technique. Hence, according to an embodiment the trenching machine further comprises: an engine arranged for driving said common axis or said at least two coaxial independent axes, and at least one torque sensor arranged for sensing the torque applied by the engine and further arranged to control the (driving when in operation) speed of said trenching machine based on the torque applied by the engine.

The forward propulsion of the machine and/or the elevation of the saw blade assembly may also be controlled by a sensor sensing the temperature of the saw blade/saw blade assembly. The sensor is allowed to control the elevation mechanism so that it automatically elevates the
saw blade in case of near overheating. This may be a way to avoid catastrophic failures of the saw blade/saw blade assembly in case of a sudden temperature increase.
CLAIMS

1. A saw blade assembly for a machine arranged for sawing trenches in an area; said area comprising a first layer L1 and a second layer L2, said first layer L1 being a hard surface layer, such as asphalt or concrete, and said second layer L2 being a bearing layer for said first layer L1 and being positioned below said first layer L1, wherein said saw blade assembly is arranged to saw through said first layer L1 and into said second layer L2; said saw blade assembly comprising:
   - at least two first type of saw blades having a working surface, at their periphery, comprising at least one segment of diamonds arranged for sawing,
   - at least one second type of saw blade having a working surface, at their periphery, comprising at least one hard material teeth arranged for digging up debris and transporting away the debris from said trench;
wherein said first type of saw blades and said second types of saw blades are complementary to each other and are alternately arranged to form said saw blade assembly, and
wherein the outermost saw blades of said saw blade assembly are of said first type of saw blades.

2. A saw blade assembly according to claim 1, wherein said first type of saw blades and said second types of saw blades are arranged on a common axis.

3. A saw blade assembly according to claim 1, wherein said first type of saw blades and said second types of saw blades are arranged on at least two coaxial independent axes.

4. A saw blade assembly according to any of the preceding claims, wherein said hard material is cemented carbide.

5. A saw blade assembly according to claim 4, wherein said cemented carbide comprises one or more substances from the group: tungsten-carbide, titanium-carbide, tantalum-carbide, and niobium-carbide.

6. A saw blade assembly according to any of preceding claims, wherein said second type of saw blades has a diameter which is less than the diameter of the first type of saw blades.
7. A saw blade assembly according to claim 6, wherein said second type of saw blades has a diameter which is 0 - 200 mm less than a diameter of said first type of saw blades.

8. A saw blade assembly according to any of the preceding claims, wherein said first type of saw blades have a diameter between 400 - 1200 mm.

9. A saw blade assembly according to any of preceding claims, wherein each of said second type of saw blades has a width of 5 - 60 mm, and preferably 5 - 40 mm.

10. A saw blade assembly according to any of preceding claims, wherein each of said first type of saw blades has a width of 2 - 30 mm.

11. A saw blade assembly according to any of preceding claims, wherein the space between the sawed width from two adjacent saw blades of said saw blade assembly is larger than -2 mm and less than 10 mm.

12. A saw blade assembly according to any of preceding claims, wherein said saw blade assembly is arranged to saw a trench having a width larger than 15 mm and less than 100 mm.

13. A saw blade assembly according to any of preceding claims, wherein at least one saw blade of said first type or said second type have cut-outs in order to reduce weight.

14. A trenching machine arranged for sawing trenches in an area, said trenching machine comprising at least one saw blade assembly according to any of preceding claims.

15. A trenching machine according to claim 14, further comprising:
   - at least one servo arranged for controlling the saw blade assembly, and
   - at least one tilt sensor arranged for sensing the tilt of said saw blade assembly and further arranged to control said servo so that said saw blade assembly is kept vertical.

16. A trenching machine according to claim 14 or 15, further comprising:
   - an engine arranged for driving said common axis or said at least two coaxial independent axes, and
   - at least one torque sensor arranged for sensing the torque applied by the engine and further
arranged to control the speed of said trenching machine based on the torque applied by the engine.
### A. CLASSIFICATION OF SUBJECT MATTER

INV.  E02F5/02  B23D59/00  B23D61/18  E02F3/18  E02F5/08  F16L1/028  H02G1/12

### B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols):

E02F  B23D  F16L  H02G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched:

Electronic data base consulted during the international search (name of data base and, where practical, search terms used):

EPO-Internal , WPI Data

### C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category*</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
</table>

* Special categories of cited documents:

**A** document defining the general state of the art which is not considered to be of particular relevance

**E** earlier application or patent 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 when the document is taken alone

*"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

*"S" document member of the same patent family

**Date of the actual completion of the international search**

19 May 2016

**Date of mailing of the international search report**

16/08/2016

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

Pedersen, Henri
This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. □ Claims Nos.:
   because they relate to subject matter not required to be searched by this Authority, namely:

2. □ Claims Nos.:
   because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. □ Claims Nos.:
   because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

This International Searching Authority found multiple inventions in this international application, as follows:

**see additional sheet**

1. □ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. □ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. □ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. □ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

   1-14

**Remark on Protest**

□ The additional search fees were accompanied by the applicant’s protest and, where applicable, the payment of a protest fee.

□ The additional search fees were accompanied by the applicant’s protest but the applicable protest fee was not paid within the time limit specified in the invitation.

□ No protest accompanied the payment of additional search fees.
This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. Claims: 1-14

The present application does not meet the criteria of Article 33(1) PCT, because the subject-matter of claim 1 is not new in the sense of Article 33(2) PCT.

In the words of independent claim 1, DI [WO2012/102659] discloses:

A saw blade assembly [200 in fig. 11] for a machine arranged for sawing trenches in an area; said area comprising a first layer L1 and a second layer L2, said first layer L1 being a hard surface layer, such as asphalt or concrete, and said second layer L2 being a bearing layer for said first layer L1 and being positioned below said first layer L1, wherein said saw blade assembly is arranged to saw through said first layer L1 and into said second layer L2; said saw blade assembly [200] comprising:

- at least two first type of saw blades [201, 203 in fig. 11] having a working surface, at their periphery comprising at least one segment of diamonds arranged for sawing [pg. 17, line 18: steel plates having diamond-impregnated segments at the periphery],
- at least one second type of saw blade [202 in fig. 11] having a working surface, at their periphery, comprising at least one hard material teeth [pg. 17, line 18] arranged for digging up debris and transporting away the debris from said trench [the rotation of 202 will bring up debris]; wherein said first type of saw blades and said second type of saw blades are complementary to each other and are alternately arranged to form said saw blade assembly [the blades are complementary and work beside one another], and wherein the outermost saw blades of said saw blade assembly are of said first type of saw blades [acc. to fig. 11, 12, the blade 202 is different from the outermost blades 201 and 203].

As stated above, claim 1 is not novel. As a result, the claims directly apppellant on claim 1 are not linked through a common inventive concept (different and non-corresponding potential technical features with different resulting technical effects and/or different objective technical problems). This leads to a lack of unity a posteriori.

The following groups of invention has been identified:

Group I containing claims: 1 - 14

The potential technical features of this group can be summarized as: multiple saw blade assembly

The technical effects associated with the above features are: improved sawing in hard ground surface

The objective technical problem solved by this invention could be formulated as: how to improve cutting?

---

2. Claims: 15, 16
Group II containing claims: 15, 16
The potential technical features of this group can be summarised as: tilt and torques sensors controlling trenching machine.
The technical effects associated with the above features are: improved control of trenching machine.
The objective technical problem solved by this invention could be formulated as: how to improve control of trenching machine?
According to the lack of unity a posteriori of this application, the partial search report has been drawn for the first invention, claims 1-14.
<table>
<thead>
<tr>
<th>Patent document cited in search report</th>
<th>Publication date</th>
<th>Patent family member(s)</th>
<th>Publication date</th>
</tr>
</thead>
<tbody>
<tr>
<td>WO 2012102659 Al</td>
<td>02-08-2012</td>
<td>AU 2012209521 B2</td>
<td>02-10-2014</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EP 2737587 Al</td>
<td>04-06-2014</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WO 2012102659 Al</td>
<td>02-08-2012</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AT 220214 T</td>
<td>15-07-2002</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AT 308137 T</td>
<td>15-11-2005</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AU 704965 B2</td>
<td>13-05-1999</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CA 2237324 Al</td>
<td>05-06-1997</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CA 2485270 Al</td>
<td>05-06-1997</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CA 2598693 Al</td>
<td>05-06-1997</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CN 1202280 A</td>
<td>16-12-1998</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DE 59609416 Di</td>
<td>08-08-2002</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DE 59611289 Di</td>
<td>01-12-2005</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EP 0861455 A2</td>
<td>02-09-1998</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EP 1211772 Al</td>
<td>05-06-2002</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EP 1619767 Al</td>
<td>25-01-2006</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ES 2179963 T3</td>
<td>01-02-2003</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ES 2251436 T3</td>
<td>01-05-2006</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 2001524218 A</td>
<td>27-11-2001</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PT 861455 E</td>
<td>29-11-2002</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 6371691 Bl</td>
<td>16-04-2002</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 2002061231 Al</td>
<td>23-05-2002</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 2005105874 Al</td>
<td>19-05-2005</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WO 9720236 A2</td>
<td>05-06-1997</td>
</tr>
</tbody>
</table>