A METHOD OF SEPARATING SCRAP, AND A DEVICE

The invention relates to a method of and a device for separating scrap comprising scrap items of a first type and of a second type, at least one of said types of scrap comprising metal. According to the invention, the method comprises the steps of passing a spot of light over the surface of a scrap item, and performing a plurality of successive light intensity measurements of light reflected from the surface to collect data from said light intensity measurements, and computing the type of scrap item based on the data; and performing a separation based on the type of scrap item.
A method of separating scrap, and a device

The present invention relates to a method of separating scrap comprising scrap items of a first type and of a second type, at least one of said types of scrap comprising metal.

Such a method is known in the art. A scrap stream, e.g. electrical components being salvaged when stripping cars, is created by transporting scrap items on a conveyor belt. A camera is used to identify the type of scrap item on the conveyor belt using object recognition and deflect a desired or undesirable scrap item of a first type so as to separate scrap items of the first type from the scrap items of the second type.

A disadvantage of the method is that it is rather expensive, requiring a camera, and powerful computer hardware to achieve a commercially acceptable throughput is required as well.

The object of the present invention is to provide a relatively simple, more cost-effective method according to the preamble.

To this end, a method according to the preamble is characterized in that the method comprises the steps of

- projecting a beam of light from a light source onto a scrap item and moving said scrap item and the beam of light relative to each other so as to pass a spot of light over the surface of said scrap item, the beam of light having at the location of said spot of light a maximum dimension D in the direction of the relative movement of the beam of light and the scrap item at the location of the spot of light on said scrap item of less than 5 mm;
- performing a plurality of successive light intensity measurements of light reflected from the surface of said scrap item in time, the light being reflected from different locations of said surface;
- collecting data from said light intensity measurements, the collected data from at least two light intensity measurements of light reflected from a scrap item constituting a set of fingerprint data;
- computing the type of scrap item based on said set of fingerprint data; and
- moving the scrap item to one of a first location and a location differing from said first location depending on the type of scrap as determined in the computing step.

Surprisingly it has been found that a set of fingerprint data
representative of the surface characteristics of a scrap item can be sufficient to distinguish between two types of items without having to rely on an image or multitude of images. Light reflected from an item can yield a fingerprint specific for that type of scrap item. Such a fingerprint can be considered a one-dimensional array, which is way simpler than the two-dimensional array obtained from a camera representing a picture of the scrap item, not in the least because a camera will in practice take many pictures of a single item, so the state of the art method has to process many two-dimensional arrays, which are rather large. For an acceptable throughput, such camera’s have to take pictures at a frequency well above what ordinary camera’s do, and such special camera’s are expensive. The present invention allows for the use of a simple sensor, such as a photocell. In general and preferably, the beam of light and the scrap item will be moved relative to each other with a constant speed, as this will result in more accurate separations. However, it is not impossible to compensate for variations in said relative speed. In case of a scrap stream where the scrap items drop, the acceleration due to gravity can be compensated for, but because the acceleration is otherwise constant, the fingerprints will reflect this and no compensation may be necessary in such a case. Moving a scrap item to a first location or other location can be done in any manner known in the art, e.g. with a robot arm, a piston pushing the item, etc. Typically, in the direction of the relative movement of the spot of light over the scrap item the speed at which the spot moves over the surface of the scrap item is at least 1 m/s, preferably with a speed of at least 2 m/s. Computing will generally be performed using a computer, although in case of a neural network this is not strictly necessary. The plurality of light intensity measurements will involve at least two measurements, but preferably more such as at least 10. In practice this number will be for example more than 50. While the locations from which light is reflected are different, they may overlap although that may not be particularly favourable. Preferably, in a set of fingerprint data there will be data of non-overlapping areas.

According to a favourable embodiment, the first type of scrap items comprises scrap items from the group consisting of motors and transformers.

This is an important application of the present invention, and it
has been found to work very well, despite scrap items being covered
with some dust and/or rust as is the case in practice. Transformers are
made up of plates, and motors have windings, both of which result in a
fingerprint markedly different from other types of scrap items such as
lumps of steel and chunks of rock or stone that may be present.

According to a favourable embodiment, the beam of light has a
maximum dimension D
in the direction of the relative movement of the beam of light and the
scrap item at the location of the spot of light on said scrap item of
less than 3 mm, preferably less than 1 mm.

This allows for obtaining more information-rich fingerprints of
each scrap item because smaller surface regularities/irregularities can
be detected.

According to a favourable embodiment, the beam of light is a laser
beam.

This allows for a narrow beam, increasing the amount of
information of the signal reflected by the scrap item. Thus, a more
reliable fingerprint can be obtained. Depending on the type of laser
used (e.g. a HeNe laser), it is quite simple to collimate and have a
small spot size that hardly varies for different distances from the
scrap item to the laser. In other words, the spot size will be adequate
irrespective of the size of typical scrap items of a given type of
scrap and there is no need for focusing depending on the size of the
scrap item.

According to a favourable embodiment, the angle between i) the
beam of light and ii) the direction of the relative motion of the scrap
item with respect to the beam of light, is fixed and at least 20°.

Phrased differently, the angle of the beam of light doesn't change
in time with respect to the vertical and to a horizontal plane. This
avoids the use of fine-mechanical apparatus components such as rotary
mirrors or prisms, wobbling mirrors etc., improving the reliability of
the apparatus in an industrial environment. This embodiment is very
easily achieved by moving scrap items of the scrap stream through the
beam of light, e.g. using a conveyor belt.

According to a favourable embodiment, the scrap items are supplied
along a path and spaced apart and subsequently the spot of light is
passed over said aligned scrap items.

The path will generally be straight, for example because the scrap
items are transported on a conveyor belt at the center thereof. Thus a stream of scrap comprising the first and second types of scrap items can be sorted quickly and conveniently.

According to a favourable embodiment, for the light intensity measurements at least two different colours are sampled.

This provides additional information that can be used to distinguish type of scrap. Measuring different colours can be performed in many ways, e.g. using two different sensors, each sensitive at a different wavelength or provided with band filters. It can, for example, also be accomplished using a single sensor and two different light sources. It is advantageous if the light sources work alternating, so as to avoid cross-talk.

According to a favourable embodiment, light intensity measurements are performed for two different polarisations of light.

For optimum signals, the polarisations will be at right angles.

According to a favourable embodiment, the scrap items are on a support surface and the location where the beam of light hits the support surface if no scrap item is in the beam of light is outside the field of view of a light sensor for performing light intensity measurements.

This results in a sharp drop in intensity measured by the light sensor, making it easy to determine the begin and the end of the path of the spot of light over the surface of the scrap item. This makes it easy to establish the beginning and the end of the dataset to make up the fingerprint of said scrap item. Limiting the field of view may be done in any of a variety of ways, e.g. using a lens, or using an aperture opening (diaphragm).

According to a favourable embodiment,
- the direction of detection,
- the direction of illumination, and
- the direction of relative movement of the scrap item with respect to the beam of light;
are in one plane.

The direction of detection is the direction from which light scattered by the scrap item is collected and the direction of illumination is the direction from which the beam of light is projected onto the scrap item. This results in an improved fingerprint and hence improves reliable identification and thus separation. The plane is
preferably an upright plane.

Finally, the present invention relates to a device for separating scrap items from scrap comprising scrap items of first type and of a second type, at least one of said types of scrap comprising metal, wherein the device comprises

- a light source capable of emitting a beam of light;
- a V-shaped conveyor belt for moving a scrap item so as to move the beam of light and the scrap item relative to each other;
- a sensor for performing light intensity measurements in time;
- collecting means arranged in communication with the light intensity sensor and arranged for creating a set of fingerprint data from at least two successive light intensity measurements obtained when the beam shines on an item of scrap;
- computing means, arranged in communication with said collecting means, and arranged for computing the type of item from a set of fingerprint data, related to a scrap item, obtained from the collecting means; and
- an actuator means capable of causing the scrap item to move to one of a first and a second location, the second location differing from the first location, on the basis of the computed type of the scrap item.

Such a device is suitable for use in the method according to the invention. The device will generally comprise an opaque housing to block at least 50% of ambient light. For the sake of brevity only so as to avoid repetition, the present invention also discloses the device with any of the modifications described in the above method claims, in any combination thereof, by reference to the above text and in particular the device features thereof. The use of a V-shaped conveyor belt set-up facilitates orientation of scrap items for high through-put purposes. The quality of the measurement is improved because (lateral) movements and/or rolling of the scrap item caused by feeding the scrap item onto the V-shaped conveyor belt are reduced, improving the quality of the fingerprint. The same goes for vibrations, which dampen out quickly on the V-shaped conveyor belt. A V-shaped conveyor belt also effects alignment which improves the identification. US2005122524 discloses a method and a device for detecting damage in plant products. The plant products such as fruit are preferably rotated while being scanned to detect damage to the plant product.

The present invention will now be illustrated with reference to
the drawing where

Fig. 1 shows a schematic cross-sectional view of a device for separating scrap items; and

Fig. 2 shows a flow diagram of signal processing steps.

Fig. 1 shows a device 100 for separating scrap items 101. In the embodiment shown here, the device 100 comprises a conveyor belt 102 for transporting scrap items 101. Over the conveyor belt 102 there is a housing 103 for excluding ambient light to a major extent, said housing 103 having an inlet opening 104 and an outlet opening 105. The housing 103 is provided with a first light source 111 with a first light detector 121. This allows for obtaining data from specular reflection and scattering properties of the surface of the scrap items 101.

In accordance with a preferred embodiment, further data are obtained concerning the colour properties of the scrap items 101. To this end, the embodiment shown here comprises a second light source 112 and a third light source 113. A beam splitter cube 114 allows superposition of the beams from said second light source 112 and third light source 113. A cylindrical lens 115 is provided to diverge the beam of light coming from said second light source 112 and third light source 113. To detect the light, there is a second light detector 122.

In the present embodiment the light sources are lasers. For separation of scrap items 101 containing copper, the second light source 112 and third light source 113 are for example blue and red. The light sources can work intermittently in an alternating way, so as to avoid cross-talk. The use of filters is thus avoided. Instead of two light sources, one could use a single white light source and use two light detectors, one for each colour.

Scrap items 101 are transported by the conveyor belt 102 through the housing 103. The first light source 111 projects a spot of light onto said scrap item 101 and light reflected by the scrap item 101 is detected by the first light detector 121. An electrical signal from the first light detector 121 is passed to a multiplexer 130 and from there to an analog-digital converter 131. Similarly, the signal from the second light detector 122 is passed to the multiplexer 130 and the analog-digital converter 131.

The signal from the analog-digital converter 131, constituting a set of fingerprint data, is passed to a computer 132, where the signal is processed as detailed below, resulting in the determination of the
scrap item type. This determination may be a positive one; i.e. the scrap item belongs to a particular type. It may also be a negative one, that the scrap item does not belong to a known scrap item type. Irrespective of that, a decision can be made what to do with the scrap item. In the embodiment shown here, the computer 132 controls a motor 141 capable of rotating a deflector plate 142 at the end of the conveyor belt 102, so as to perform the separation. With a known speed of the conveyor belt 102, the computer 132 will take the time it takes from passing through the housing 103 to the location of the deflector plate 142 into account, thus deflecting the appropriate scrap item 101.

Fig. 1 also shows the field of view of the second light detector 122. It should be noted that without a scrap item 101 being present, the beam from the second light source 112 hits the conveyor belt 102 outside the field of view of the second light detector 122. This results in an improvement of the signal quality, helping in detecting the presence of a scrap item.

As can be seen in Fig. 1, the direction of detection (direction from which light scattered by the scrap item is collected), the direction of illumination and the direction of them movement of the scrap item are in an vertical plane.

Fig. 2 shows a flow diagram of a convenient way of processing data from a light detector, such as the first light detector 121, in a process wherein motors and transformers were separated from lumps of steel. Because of the presence of windings or plates, the surface characteristics differ from those of lumps of steel. The size of these scrap items 101 was 2 to 15 cm and their height was in the range of 5 to 50 mm. As a result of the varying height, the spot size had a dimension parallel to the belt between 0.2 and 0.5 mm. The scrap items 101 were positioned in a longitudinal direction on the belt 102. The belt 102 moved with a speed of 3 m/s and the sampling frequency of the ADC convertor (14 bit) was 40 KHz.

The signal from the ADC converter is subjected by a program run on computer 132 to a step to remove an off-set, for example caused by background light that may have entered the housing 103. This increases the contrast for the second step, where the presence of a scrap particle is detected because the signal level exceeds a threshold value. This defines a data window and data from this data window is in the form of an array of data (i.e. what in the present application is
indicated as the set of fingerprint data) that may be subjected to a step to remove spikes in the data of the data window. Spikes are for example caused by dust in the air. Spike removal is, for example, performed by taking 5 consecutive data values, determining whether any of the data value numbers 2 to 4 are above a threshold value compared to data value numbers 1 and 5. If so, then the data value numbers 2 to 4 are replaced by the average values of data value numbers 1 and 5. If not, no values of data value numbers are changed and the data value numbers 2 to 6 are examined similar as just described for data value numbers 1 to 5, etc. This results in pre-processed signal S0. The threshold to discern what is a spike and what is not a spike depends on the particular circumstances (scrap items to be separated) and can easily be determined, using the raw data stream from the ADC converter 131 and looking at outliers.

The pre-processed signal S0 is subjected to a step wherein a 1 mm moving average is determined. That is, all the data values obtained while a scrap item 101 moved over a distance of 1 mm on the belt 102 are averaged. This results in a signal S1. The difference between S0 and S1 represents high frequencies and is signal S2.

Signal S1 is subjected to a step wherein a 4 mm moving average is determined, resulting in signal S4, representative of low frequencies. The difference between S1 and S3 is representative of intermediate frequencies (signal S4).

The signals S0 to S4 are used to calculate a simplified data set, called extracted data. These extracted data are then fed into an Adaboost program. Adaptive boosting is a well-known technique for machine learning and classification. Reference: Adaptive Boosting (Adaboost), a machine learning algorithm formulated by Yoav Freund and Robert Schapire. (A Decision-Theoretic Generalization of on-Line Learning and an Application to Boosting (1995)). Several open source programs are available, see for example wikipedia (http://en.wikipedia.org/wiki/AdaBoost).

For classification, the person skilled in the art may instead employ any other of various techniques well disclosed in the art. For example: Principal Components Analysis (http://www.cs.otago.ac.nz/cosc453/student_tutorials/principal_components.pdf) and linear discriminant analysis.

Training was done with 30-50 scrap items of each type.
To process colour-based information from the second light detector 122, this too was subjected to signal processing as disclosed above, but separating the data belonging to light from the second light source 112 and the third light source 113 first, based on the time when light was emitted. This results in two additional data arrays, allowing further computational parameters to be calculated. For example, the difference in signal strength between the data of said colours can be used as a signal S5.

The method according to the present invention has been found to be more accurate (>80%) than a human sorter (50-60%), whose accuracy is subject to concentration and motivation. The present method is also much faster. To achieve the above results, the features extracted from S0 to S4 and fed to the Adaboost program were

1. mean[ abs(S2) ] / max(S1)
2. mean[ abs(S2) / S1 ]
3. mean[ abs(S2) > 0.3*max(abs(S2)) ]

where abs means the absolute value of and max means the maximum value of. The last feature (feature 3) is a logical operation. If the absolute value of an S2 value in the data array for this scrap item is larger than 30% of the largest S2 value, THEN it is assigned a value of 1, ELSE it is assigned a value of 0. The average of all ones and zero's is determined to result in a single value for feature 3. Thus the original light signal measured from the scrap item 101 is reduced to three values, which are fed to the Adaboost program. It is believed that a further improved sorting result can be obtained by reducing the sensitivity for a single maximum (max) value, e.g. by using the average of the 10% highest values. It should be noted that, the Adaboost program is trained using scrap items of the various types, the training being done under particular circumstances (e.g. speed of the conveyor belt, sampling frequency etc.) a change in circumstances may need retraining to achieve the desired quality of separation.

With the method according to the present invention, further optical properties may be exploited, in particular polarization. To this end and by way of example, the second light source 112 and the third light source 113 may be linearly polarized lasers angled and operated such that the scrap item 101 is subjected alternately to H and V polarized light. This is e.g. useful for separating metals from dielectric materials such as stones. Alternatively, a non-polarized or
circularly polarized light source may be used, with two sensors each provided with a polarization filter to detect the desired H and V component.

The use of a V-shaped conveyor belt set-up facilitates orientation of scrap items for high through-put purposes. A V-shaped conveyor belt is available from BCK Holland (Waalwijk, The Netherlands), and comprises two directly-driven conveyor belts at an angle of 30° with respect to the horizontal. The gap between two belts is less than 5 mm. The conveyor belts are frequency-controlled so as to have identical speed.
CLAIMS

1. A method of separating scrap comprising scrap items (101) of a first type and of a second type, at least one of said types of scrap comprising metal, characterized in that the method comprises the steps of
- projecting a beam of light from a light source (111) onto a scrap item (101) and moving said scrap item (101) and the beam of light relative to each other so as to pass a spot of light over the surface of said scrap item (101), the beam of light having at the location of said spot of light a maximum dimension D in the direction of the relative movement of the beam of light and the scrap item (101) at the location of the spot of light on said scrap item (101) of less than 5 mm;
- performing a plurality of successive light intensity measurements of light reflected from the surface of said scrap item (101) in time, the light being reflected from different locations of said surface;
- collecting data from said light intensity measurements, the collected data from at least two light intensity measurements of light reflected from a scrap item (101) constituting a set of fingerprint data;
- computing the type of scrap item (101) based on said set of fingerprint data; and
- moving the scrap item (101) to one of a first location and a location differing from said first location depending on the type of scrap as determined in the computing step.

2. The method according to claim 1, wherein the first type of scrap items (101) comprises scrap items (101) from the group consisting of motors and transformers.

3. The method according to claim 1 or 2, wherein the beam of light has a maximum dimension D in the direction of the relative movement of the beam of light and the scrap item (101) at the location of the spot of light on said scrap item (101) of less than 3 mm, preferably less than 1 mm.

4. The method according to any of the preceding claims, wherein the beam of light is a laser beam.
5. The method according to any of the preceding claims, wherein the angle between i) the beam of light and ii) the direction of the relative motion of the scrap item (101) with respect to the beam of light, is fixed and at least 20°.

6. The method according to any of the preceding claims, wherein the scrap items (101) are supplied along a path and spaced apart and subsequently the spot of light is passed over said aligned scrap items (101).

7. The method according to any of the preceding claims, wherein for the light intensity measurements at least two different colours are sampled.

8. The method according to any of the preceding claims, wherein light intensity measurements are performed for two different polarisations of light.

9. The method according to any of the preceding claims, wherein the scrap items (101) are on a support surface and the location where the beam of light hits the support surface if no scrap item (101) is in the beam of light is outside the field of view of a light sensor for performing light intensity measurements.

10. The method according to any of the preceding claims, wherein
- the direction of detection,
- the direction of illumination, and
- the direction of relative movement of the scrap item with respect to the beam of light;
are in one plane.

11. A device (100) for separating scrap items (101) from scrap comprising scrap items (101) of first type and of a second type, at least one of said types of scrap comprising metal, wherein the device (100) comprises
- a light source (111) capable of emitting a beam of light;
- a V-shaped conveyor belt (102) for moving a scrap item (101) so as to
move the beam of light and the scrap item (101) relative to each other;
- a sensor (121) for performing light intensity measurements in time;
- collecting means (131) arranged in communication with the light intensity sensor (121) and arranged for creating a set of fingerprint data from at least two successive light intensity measurements obtained when the beam shines on an item (101) of scrap;
- computing means (132), arranged in communication with said collecting means (131), and arranged for computing the type of item (101) from a set of fingerprint data, related to a scrap item (101), obtained from the collecting means (131); and
- an actuator (142) means capable of causing the scrap item (101) to move to one of a first and a second location, the second location differing from the first location, on the basis of the computed type of the scrap item (101).
Fig. 2
A. CLASSIFICATION OF SUBJECT MATTER

INV. B07C5/342
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B07C

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 practicable, 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>
<tbody>
<tr>
<td>Y</td>
<td>EP 1 698 888 A2 (TITECH VISIONSORT AS [NO]) 6 September 2006 (2006-09-06) figure 8</td>
<td>11</td>
</tr>
<tr>
<td>Y</td>
<td>EP 1 975 603 A1 (VISYS NV [BE]) 1 October 2008 (2008-10-01) abstract; figures</td>
<td>11</td>
</tr>
<tr>
<td>Y</td>
<td>GB 2 070 464 A (KUREHA CHEMICAL IND CO LTD) 9 September 1981 (1981-09-09) figures</td>
<td>11</td>
</tr>
</tbody>
</table>

X Further documents are listed in the continuation of Box C. X See patent family annex.

* 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:

4 April 2013

Date of mailing of the international search report:

17/04/2013

Name and mailing address of the ISA/IB

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

Authorized officer

Wich, Roland
<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>
<tbody>
<tr>
<td>Y</td>
<td>WO 02/12095 A1 (TOMRA SYSTEMS ASA [NO]; HOLMEN KRISTIAN [NO]; ROGNHAUG JACOB SOEMMING) 14 February 2002 (2002-02-14) figures</td>
<td>11</td>
</tr>
<tr>
<td>Y</td>
<td>GB 1 322 423 A (BROUWER &amp; CO MACHINE) 4 July 1973 (1973-07-04) figure 3</td>
<td>11</td>
</tr>
<tr>
<td>Y</td>
<td>US 4 901 861 A (CICCHELLI MARTIN D [US]) 20 February 1990 (1990-02-20) figure 1A</td>
<td>11</td>
</tr>
<tr>
<td>Y</td>
<td>DE 43 29 193 A1 (LUCHT HARTMUT DR RER NAT [DE]) 2 March 1995 (1995-03-02) figure 1</td>
<td>11</td>
</tr>
<tr>
<td>Patent document cited in search report</td>
<td>Publication date</td>
<td>Patent family member(s)</td>
</tr>
<tr>
<td>--------------------------------------</td>
<td>-----------------</td>
<td>-------------------------</td>
</tr>
<tr>
<td>US 2005122524</td>
<td>09-06-2005</td>
<td>AR 046866 A1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AU 2004304823 A1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BR P10416536 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CN 1890032 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EP 1711282 A2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 2007514526 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NZ 547308 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 2005122524 A1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WO 2005060429 A2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ZA 200604132 A</td>
</tr>
<tr>
<td>EP 1698888</td>
<td>06-09-2006</td>
<td>NONE</td>
</tr>
<tr>
<td>EP 1975603</td>
<td>01-10-2008</td>
<td>AU 2008231710 A1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CN 101680844 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EP 1975603 A1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EP 2140250 A2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TR 200907293 T2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 2010046826 A1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WO 2008116924 A2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AU 6751681 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CA 1166994 A1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DE 3105386 A1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FR 2476509 A1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>GB 2070464 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 4432457 A</td>
</tr>
<tr>
<td>WO 0212095</td>
<td>14-02-2002</td>
<td>AT 280114 T</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AU 8028601 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CA 2416905 A1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DE 01958661 T1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DE 20112651 U1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DE 60106632 D1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DE 60106632 T2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 5033299 B2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 2004505866 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NO 20003976 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 2003187546 A1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WO 0212095 A1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DE 7124251 U</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FR 2096599 A1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>GB 1322423 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NL 7009614 A</td>
</tr>
<tr>
<td>US 4901861</td>
<td>20-02-1990</td>
<td>NONE</td>
</tr>
<tr>
<td>DE 4329193</td>
<td>02-03-1995</td>
<td>NONE</td>
</tr>
</tbody>
</table>