Title: PHOTOCATALYTIC AIR PURIFIER

Abstract: Disclosed herein is a photocatalytic air purifier. The purifier (1) comprises an air passage (10), a plurality of catalyst screens (11) arranged oblique to the right angle of the axis of air flow through the air passage (10), a drive means (30) to force air through the air passage (10), a plurality of electromagnetic radio wave sources (13) to activate the catalyst screens (11) and the air within the air passage (10). The plurality of electromagnetic radio wave sources (13) are disposed within the air passage between adjacent screens (11).
PHOTOCATALYTIC AIR PURIFIER

Field of the Invention

[0001] The present invention relates to a photocatalytic air purifier.

Background to the Invention

[0002] A photocatalytic air purifier is a device that uses photocatalytic oxidation (PCO), to convert fine particles (0.1 micron order) particles and toxic gases into safer compounds. PCO is an approved method for reducing bacteria in poultry and pork processing, and is used to cleanse pesticides from fruits and vegetables. Typical photocatalytic air purifiers use broad spectrum ultraviolet light, which reacts with a thin-film titanium dioxide-based chemical catalyst, to create hydroxyl radicals and super-oxide ions which oxidize volatile organic compounds (VOCs), and eliminate microorganisms adsorbed on the catalyst surface.

[0003] High-intensity broad spectrum ultraviolet light, with UVC (254 nm) germicidal light wavelengths included, is the first part of photocatalytic air purification technology and acts directly on the air. A wider set of ultraviolet wavelengths below 385nm are employed for catalyst activation. Although UV light alone will degrade toxic organic compounds, reaction rates are much faster with photocatalytic assistance.

[0004] Typically the catalyst material in a photocatalytic purifier is titanium dioxide, TiO2, which is applied as a thin film on aluminium or ceramic substrates. Titanium dioxide is a relatively inexpensive pigment and is used to add whiteness to products such as paints and coatings, plastics, paper, inks, fibres, food, toothpaste and cosmetics. Titanium dioxide is also a semiconductor.

When a semiconductor is bombarded with light of certain wavelengths, electrons in the material's valence band are excited into the conduction band. This means they are free to move and their energy ends up splitting nearby water molecules into two parts, hydroxyl radicals and super-oxide ions. Hydroxyl radicals are among the most powerful oxidizers in the world, stronger than chlorine, ozone, and peroxide, and consequently very short lived. Superoxide is created
by the addition of one electron to oxygen. This free radical has a relatively long half-life: less than one second.

[0005] Organic substances, like germs and volatile organic compounds, are held together by carbon-carbon, carbon-oxygen or carbon-hydrogen bonds. Oxidizers chop these bonds and cut the molecule into smaller compounds which are broken over and over until only carbon dioxide and water are left. A photocatalytic purifier can eliminate particles up to approximately 0.01 microns in size from air. Pollens, dust mite allergens, pet dander, mould, bacteria, and viruses in the air, are on the list of items removed. Larger particles, such as pet hair, require a pre-filter. Photocatalytic air purifiers can also eliminate toxic gas phase VOC pollutants including formaldehyde, exhaust fumes, benzene, ethylene, toluene, and odours like ammonia and hydrogen sulphide from the air. Even gases like carbon monoxide and nitrous oxide are destroyed.

[0006] One of the problems with existing photocatalytic air purifiers however is that the substrate the catalyst is coated on to inhibits the motion of air through the device. Furthermore the substrates inevitably block the passage of the UV light in certain areas of the purifier. This reduces the overall efficiency of the machines currently on the market place. The immediate solution is to increase the force of the air moving through the device, but this increases the overall amount of noise that the device generates, which is undesirable for most consumers. Furthermore, increasing air flow is counter-productive as it reduces the overall dose of UV the air is exposed to (as the air moves through the device faster). It is possible to increase UV capacity, but this generally increases the overall power requirements.

[0007] There has now been devised a photocatalytic air purifier which overcomes and/or substantially mitigates the above referenced disadvantages associated with the prior art.

Summary of the Invention

[0008] The present invention provides a photocatalytic air purifier comprising

   an air passage,
a plurality of catalyst screens arranged oblique to the right angle of the axis of air flow through the air passage,

a drive means to force air through the air passage,

a plurality of electromagnetic radio wave sources to activate the catalyst screens and the air within the air passage, wherein

the plurality of electromagnetic radio wave sources are disposed within the air passage between adjacent screens.

[0009] For the purposes of the present invention, activation of the catalyst screens means to activate the catalyst present on the screens. For the purposes of the present invention, activation of the air within the air passage means to expose the air within the air passage to the electromagnetic radio wave energy.

[0010] The photocatalytic air purifier according to the invention is advantageous primarily because the surface area of the screens exposed to the incoming air is increased compared to that of conventional devices. Furthermore, the inventors have found a surprising increase in the UV power per cm² that each screen is exposed to. Therefore the efficiency of the catalyst is increased. Also, the present invention induces considerable turbulent air flow within the air passage, which increases the time the air is spent exposed to the catalyst and the UV. All of this leads to more efficient killing of pathogens and greater removal of harmful gasses and odours.

[0011] The catalyst screens are preferably arranged in a pleated configuration across an air passage. A pleated configuration with respect to the present invention means that neighbouring screens are arranged oblique to the right angle of the axis of air flow through the air passage, but tilted in opposing directions. That is to say, one screen will be tilted away from the right angle of the axis of air flow in a first direction, and the adjacent screen will be tilted away from the right angle of the axis of air flow but in a second direction, wherein the first direction is opposite the second direction. Neighbouring screens may be in contact with one another or separated. The screens may be held in situ by fastenings such as brackets, or have edge portions configured to engage in chan-
nels formed in the housing. The catalyst screens may alternatively be arranged in a slanting configuration. That is to say, rather than adjacent screens being tilted as described above and wherein the first direction is opposite the second direction, the first direction may be the same as the second direction. Thus all or some of adjacent screens may be slanted in substantially the same direction.

[0012] The catalyst screens are coated with at least one photo catalyst selected from the group consisting of titanium dioxide, zinc oxide, tin dioxide and cerium dioxide. Preferably the photo catalyst used in the present invention is titanium dioxide as this compound is regarded as having the highest stability and being the most efficient and having a lower cost than other photo catalysts. Preferably the titanium dioxide is a sol-gel preparation. Preferably the photo catalyst further comprises a dopant. Preferably the dopant is 10% w/v or more silica. If titanium dioxide is used, then preferably the type of catalyst is the anatase form of the titanium dioxide. This is because titanium dioxide can go through phase formation to the rutile form which is much less useful in the reaction phase with the UVC germicidal light source to form the OH2 radical. The reason the anatase is the better form is that the hydroxyl group is removed easier from anatase form. This then increases the rate of attack on organic compounds. To suppress the growth of the crystal grain and also inhibit phase transformation from anatase to rutile the silica is added at 10% or more of the weight, as the silica increases the surface area of the TiO2 increases, this improves the ability to form OH2 radicals.

[0013] The screens may be interconnected. That is to say one edge of each screen is in contact with an edge of an adjacent screen. It is recognised however that connection is not necessary for the device to function and the screens may be separated from one another.

[0014] The drive means may comprise at least one fan. The at least one fan may be capable of driving air through the passageway at up to 700m$^3$ per hour. Preferably the at least one fan drives air through the passageway at 640m$^3$ per hour. In a preferred embodiment of the invention there are three fans. Preferably the drive means are mounted within the air passageway. The drive means
may be in line devices. Examples of in line devices include but are not limited to in line fans.

[0015] It is recognised that the invention could incorporate a number of electromagnetic radio wave sources in order to purify the air as it travels through the passage way. Preferably, the electromagnetic radio wave sources comprise ultraviolet light sources. UV light is recognised for its germicidal capability as well as its ability in activating the photo catalyst.

[0016] The electromagnetic (EM) radio wave sources may comprise fluorescent tubes. This provides a neat and controllable light source and one which is relatively inexpensive to produce and uses low power. Furthermore the tubes can be configured in a longitudinal fashion so as to extend across the air pas sageway (see later). Suitable other examples of EM radio wave sources include but are not limited to bulbs, lamps, LED's or lasers. The EM radio wave sources are disposed within the air passage between adjacent screens. That is to say, the EM radio wave sources, in the case where screens are in a plated configuration, are disposed within spaces defined by the pleats.

[0017] The electromagnetic radio wave sources preferably transverse the air passage. This has the effect that the intensity of radiation across the air passage is constant.

[0018] The electromagnetic radio wave sources preferably extend at right angles to the axis of air flow through the passage. This has the effect that the radiation has the greatest contact with the incoming air and sources are then able to create turbulent air flow within the air passage.

[0019] The electromagnetic radio wave sources are preferably arranged in a staggered configuration within the air passage. This further increases the exposure of the catalysts screens to the EM energy and further increases the turbulent air flow.

[0020] The air passage may comprise a tubular housing. This enables the containment of the air passage and prevents the UV light from escaping. The tubular housing may be any cross section. The drive means is preferably locat-
ed at one end of the tubular housing, but it is recognised that an in line drive means may also function sufficiently.

[0021] The tubular housing preferably has reflective internal surfaces. In this way the EM energy is reflected off the inside of the housing and increases the exposure of the air to the EM energy as well as the catalysts screens.

[0022] The tubular housing may be formed from anodised aluminium, this provides sufficient reflectivity to reflect 70% of the EM energy. This has the effect that more of the EM energy produced is actually utilised in activating the catalyst and the air.

[0023] The catalyst screens preferably comprise a framework which supports one or more perforated screens or mesh works. The photo catalyst is coated onto the perforated screens or mesh works. Preferably the perforated screens or mesh works are manufactured from stainless steel as this gives the best form of bonding for the photo catalyst. Also, the stainless steel has good structural integrity and is not susceptible to attack when being coated by Sol Gel, which has high photo activity on stainless steel. Each catalyst screen may comprise a plurality of perforated screens or mesh works superimposed on top of one another. Each of the perforated screens or mesh works may be configured differently, i.e. have a different number of perforations or size of perforations for example. In a preferred embodiment, each catalyst screen comprises three perforated sheet layers, with the two outer sheets of one type of formation and the centre one of a different type thus creating a different surface area which will improve the dwell time of the air flow passing through the filter. Improving the dwell time improves the photo activity of the purifier.

[0024] The photocatalytic air purifier according to the invention in use removes ethylene, bacteria, fungi, viruses and/or odours from the air within the air passage.

**Brief Description of the Drawings**

[0025] The description herein makes reference to the accompanying drawings wherein like reference numerals refer to like parts throughout the several views, and wherein:
Figure 1 is a three dimensional perspective view of a first embodiment of the photocatalytic air purifier according to the invention.

Figure 2 is a three dimensional perspective view of an embodiment of the photocatalytic air purifier according to the invention showing the fan arrangement.

Figure 3 is a cross sectional view of the first embodiment of the photocatalytic air purifier according to the invention.

Figure 4 is a three dimensional perspective view of a second embodiment of the photocatalytic air purifier according to the invention.

Figure 5 is a three dimensional perspective view of a third embodiment of the photocatalytic air purifier according to the invention.

**Detailed Description of the Illustrated Embodiment**

In figure 1 there is shown a photocatalytic air purifier according to the invention, generally designated 1. The air purifier 1 comprises a HEPA (High-Efficiency Particulate Arrestance) filter box 2 which is connected to a fan housing 3 which is in turn connected to a light box 4. The filter box 2, fan housing 3 and light box 4, are all in fluid communication with each other and can travel from one through to the other. The HEPA filter box 2 comprises a rectangular housing having an air inlet 5. Within the filter box 2 there are a number of HEPA filters to filter out particles which enter the purifier 1. The HEPA filter box and the filters are optional however, and are only required where there is a specific need to remove viruses and spores from the air before it enters the light box. The HEPA filters are H13 class filters which will remove particles down to 0.01 micron and is 99.9999% efficient as its Arrestance measure. The fan housing 3 comprises three in line fans (not shown). These fans are arranged across the width of the fan housing 3 from one side 3a to the other opposite side 3b. Cumulatively the fans are capable of blowing air into the light box 4 at 640 m³ per hour. Downstream of the fans there is the light box 4 which comprises a tubular housing of rectangular cross section, the housing being made from anodised aluminium. At the end of the light box 4 opposite the fan housing there is an air outlet 6. In the embodiment shown the outlet 6 comprises an angled orifice
which directs the air out of the light box 4 generally at right angles to the direction of air flow through the air passageway, which is defined by the housing of the lightbox 4. It will be appreciated that the purifier 1 as shown could be orientated in any direction, so that the air coming out of the outlet 6 is not necessarily directed upwardly as shown in the figures. To support the purifier 1 for example from a solid structure such as a ceiling or framework structure, four hangers 7 are present, one at each corner of the lightbox 4. The hangers 7 are attached to the external parts or brackets of the lightbox 4 and in the embodiment shown extend upwardly in the same direction as the outlet 6.

[0032] The type of HEPA filters present within the filter box 2 are optional depending on the customer requirements. In the embodiment described the fans are centrifugal module fans that are backward-curved and each have a single intake with housing. Other types are fan would be suitable though. Examples of the typical fans used are shown in figure 2, which shows the purifier 1 without the filter box 2 attached. The fans 40, 42 and 44 are each arranged across an opening to the lightbox 4. Each fan sucks dirty air inwards and forces it out through the outlet 6. The three fans 40, 42 and 44 are in line fans powered by an electrical power source (not shown).

[0033] Line a-b in figure 1 shows the main longitudinal axis of the purifier, and in use air flows in the direction from a to b within a passageway which is defined by the housing of the lightbox. A cross section of the purifier 1 through the line a-b is shown in figure 3. The air passageway described above is shown 10. Within the air passageway 10 there are eleven catalyst screens 11. For clarity only two of these screens are labelled. The screens 11 are supported in a pleated configuration within the air passage by brackets 12. The screens 11 extend from one side of the lightbox 4 to the opposite side across the air passageway (shown as 4a and 4b in figure 1) and generally at right angles to the direction of air (a-b) moving through the air passageway in use. Each screen is oblique to the vertical, and thus each screen is tilted away from an angle at right angles to the direction of air through the passageway, in order to form the pleated configuration. Each screen extends from the bottom face 4c of the lightbox 4 to the top opposite face 4d. Each screen 11 measures 790mm x
205mm and comprises three stainless steel mesh sheets. Using a Sol-Gel process, each mesh sheet has coated onto it a titanium dioxide film. Between each screen there are two fluorescent tubes 13a, 13b, which emit UV light in use. The tubes are Pro UV 4 pin single ended 845 mm long Teflon coated UV germicidal 254nm 90W. The sets of tubes 13 are arranged in a staggered configuration in order to increase the exposure of the screens to UV and increase the turbulent air flow through the air passageway. The tubes 13 extends from one side 4a of the light box 4 to the other side 4b and are in electrical communication with a power source (not shown).

[0034] The purifier 1 comprises an external casing 20 which encases the majority of the purifier 1. This is shown in Figure 4. The case 20 is made from stainless steel. The casing 20 has an opening 22 at one end which marries up with the air inlet 5 of the HEPA filter housing. The casing 20 also has an air outlet 24 which marries up with the air outlet 6. The outlet 24 is covered with an angled grill to help further direct the air away from the purifier. The hangers 7 protrude through the casing 20. The casing 20 is connected to the purifier by fixings around the edge of the casing.

[0035] The casing may optionally further comprise a self-cleaning intake filter 30 as shown in Figure 5. This is a device to partially clean the air before it enters the light chamber or the filter box. The intake filter 30 is bolted to the casing and covers the air inlet 5 and the opening 22. The intake filter 30 is a sort of pre-cleaning filter and has a 90% Ure Arrestance measure of synthetic dust.

[0036] In use, power is provided to the tubes 13, which causes them to energise, and emit UV light. Simultaneously the fans (which are also connected to a power source) shown as fans 30 in figure 2, within the fan housing 3 begin to operate. The operation of the fans causes dirty air to be drawn into the air inlet 5 of the HEPA filter housing 2. The air is pulled over the HEPA filters within the filter housing 2, and this removes viruses, yeasts and spores. The partially cleaned air is then pulled through the fans and is forced through the lightbox 4. In doing so the air passes through and over the screens 11, and around the tubes 13. The UV light works in two ways. Firstly it acts directly on the incum-
bent air. It has a generally germicidal effect. Secondly it activates the catalyst (in this case titanium dioxide) coated onto the screens 11. The activation of the photo catalyst causes the production of free radicals, hydroxyl radicals and super-oxide ions which cleans the air as described in the introduction above. After passing through the lightbox 4, the cleaned air then exits the purifier 1 from the outlet 6 and the outlet 24 of the casing.

[0037] In a further example of the invention the purifier is substantially as described above, however the air is forced through the passageway at 67m3 per hour and the UV lamps are 4.1W.

[0038] In a further example of the invention the purifier is substantially as described above, but instead of three fans there are two side by side.

[0039] The inventors have surprisingly found that the cleaning effect of the purifier is markedly enhanced from that of known devices which adopt conventional non pleated arrangement of the screens and different arrangements for the tubes. In particular the screens have exposed to them approximately 4W/cm2 of UV light, which is compared to 2 W/cm2 for conventional devices. The purifier is therefore particularly efficient at removing ethylene, bacteria, odours and viruses from the air. The inventors postulate that the enhanced effect of the purifier according to the invention is due to an increased amount of turbulent air flow within the light box, and an increase in the surface area of the catalysts screens exposed to the UV light (both compared to conventional devices).

[0040] This effect is demonstrated in the following example.

[0041] 1. Experiment to show the ability of the air purifier according to the invention to remove ethylene from the air.

[0042] Aim: To determine the ability of the air purifier to remove ethylene from the air.

[0043] Method: The air purifier (as described above) was placed in a gas tight test room. A BRM ethylene generator (BRM Ethylene Generator series 3 Serial No 8095) was turned on. A pre-calibrated sensor (Sensorex SX91 2 serial
No. 15441 using the SIP 10% certified calibration gas) was then used to monitored the ethylene level in the room. When 650ppm was achieved the ethylene generator was switched off. The air purifier was then switched on and the ethylene level in the room was logged with respect to time.

Results: The results of this experiment are shown below. The amount of ethylene remaining in the room with time is indicated as follows:

Starting point 650ppm (ethylene)
  after 2min  600ppm
  after 85 min  452ppm
  after 90 min  440 ppm
  after 100 min  397 ppm
  after 110 min  395 ppm

Conclusion: This experiment shows that the air purifier is able to significantly and dramatically reduce the level of ethylene in the atmosphere (in this case in the room) in a very short space of time. After only 110 minutes approximately 40% of the starting amount of ethylene had been removed. The inventors have been surprised by the effects observed.
CLAIMS

1. A photocatalytic air purifier comprising
   an air passage
   a plurality of catalyst screens arranged oblique to the right angle
   of the axis of air flow through the air passage.
   a drive means to force air through the air passage
   a plurality of electromagnetic radio wave sources to activate the
   catalyst screens and the air within the air passage, wherein
   the plurality of electromagnetic radio wave sources are disposed
   within the air passage between adjacent screens.

2. A photocatalytic air purifier according to claim 1, wherein the cata-
   lyst screens are arranged in a pleated configuration across an air passage.

3. A photocatalytic air purifier according to claim 1 or claim 2, where-
   in the catalyst screens are coated with titanium dioxide.

4. A photocatalytic air purifier according to any preceding claim, wherein
   the screens are interconnected.

5. A photocatalytic air purifier according to any preceding claim, wherein
   the drive means comprises at least one fan.

6. A photocatalytic air purifier according to any preceding claim, wherein
   the electromagnetic radio wave sources comprise ultraviolet light
   sources.

7. A photocatalytic air purifier according to any preceding claim, wherein
   the electromagnetic radio wave sources comprise fluorescent tubes.

8. A photocatalytic air purifier according to any preceding claim, wherein
   the electromagnetic radio wave sources transverse the air passage.

9. A photocatalytic air purifier according to any preceding claim, wherein
   the electromagnetic radio wave sources extend at right angles to the
   axis of air flow through the passage.

10. A photocatalytic air purifier according to any preceding claim, wherein
    the electromagnetic radio wave sources are arranged in a staggered
    configuration within the air passage.
11. A photocatalytic air purifier according to any preceding claim, wherein the air passage comprises a tubular housing.

12. A photocatalytic air purifier according to claim 11, wherein the tubular housing has reflective internal surfaces.

13. A photocatalytic air purifier according to claim 11 or claim 12, wherein the tubular housing is formed from anodised aluminium.

14. A photocatalytic air purifier according to any preceding claim, wherein the catalysts screens comprise a framework which retains a one or more perforated screens or mesh works.

15. A photocatalytic air purifier according to any preceding claim, wherein the catalyst screens are coated with an anatase form of titanium dioxide.

16. A photocatalytic air purifier according to any preceding claim which in use removes ethylene, bacteria, viruses and/or odours from the air within the air passage.
## A. Classification of Subject Matter

**INV. A61L9/20**

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)

A61L

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

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"anatase" ; paragraph [0010] paragraph [0020] ; figure 1  | 1-16                  |
column 6, line 59 - column 7, line 22; figure 1  | 1-16                  |
| X        | EP 1 426 065 AI (ZEXEL VALEO CLIMATE CONTR CORP [JP]) 9 June 2004 (2004-06-09)  
paragraphs [0047] - [0049]; figures 1, 4  | 1-16                  |

[Check mark symbol] Further documents are listed in the continuation of Box C.  
[Check mark symbol] See patent family annex.

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Name and mailing address of the ISA:

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### DOCUMENTS CONSIDERED TO BE RELEVANT

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<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
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<tr>
<td>X</td>
<td>wo 2011/135601 A1 (ZUPIN ELIGI0 [IT] ) 3 November 2011 (2011-11-03) page 8, line 10 - page 9, line 15; figure 5 “fan” ; page 9, line 21</td>
<td>1-16</td>
</tr>
<tr>
<td>Patent document cited in search report</td>
<td>Publication date</td>
<td>Patent family member(s)</td>
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<tr>
<td>US 2008031783 AI</td>
<td>07-02-2008</td>
<td>NONE</td>
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<table>
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<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>US 6797127 BI</td>
<td>28-09-2004</td>
<td>AU 5709600 A</td>
<td>05-02-2001</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CN 1362886 A</td>
<td>07-08-2002</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DE 10084820 T1</td>
<td>19-12-2002</td>
</tr>
<tr>
<td></td>
<td></td>
<td>GB 2367495 A</td>
<td>10-04-2002</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 6797127 BI</td>
<td>28-09-2004</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WO 0105441 AI</td>
<td>25-01-2001</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EP 2489373 AI</td>
<td>22-08-2012</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 4159462 B2</td>
<td>01-10-2008</td>
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<tr>
<td></td>
<td></td>
<td>JP WO 2002102423 AI</td>
<td>21-10-2004</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 2004170537 AI</td>
<td>02-09-2004</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WO 02102423 AI</td>
<td>27-12-2002</td>
</tr>
<tr>
<td>WO 2006065491 A2</td>
<td>22-06-2006</td>
<td>AU 2005316888 AI</td>
<td>22-06-2006</td>
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<tr>
<td></td>
<td></td>
<td>CA 2585998 AI</td>
<td>22-06-2006</td>
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<tr>
<td></td>
<td></td>
<td>CN 101076396 A</td>
<td>21-11-2007</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EP 1824594 A2</td>
<td>29-08-2007</td>
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<tr>
<td></td>
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<td>EP 2377608 AI</td>
<td>19-10-2011</td>
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<td></td>
<td></td>
<td>ES 2398915 T3</td>
<td>22-03-2013</td>
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<td>HK 1115345 AI</td>
<td>19-02-2016</td>
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<tr>
<td></td>
<td></td>
<td>JP 2008522822 A</td>
<td>03-07-2008</td>
</tr>
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<td></td>
<td></td>
<td>KR 20070084604 A</td>
<td>24-08-2007</td>
</tr>
<tr>
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<td>US 2006127288 AI</td>
<td>15-06-2006</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 2010196223 AI</td>
<td>05-08-2010</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WO 2006065491 A2</td>
<td>22-06-2006</td>
</tr>
<tr>
<td>WO 2011135601 A1</td>
<td>03-11-2011</td>
<td>IT 1399279 AI</td>
<td>03-05-2013</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WO 2011135601 AI</td>
<td>03-11-2011</td>
</tr>
<tr>
<td>US 2013171031 AI</td>
<td>04-07-2013</td>
<td>AU 2008254793 AI</td>
<td>27-11-2008</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CA 2685256 AI</td>
<td>17-11-2008</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CN 101790389 A</td>
<td>28-07-2010</td>
</tr>
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