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JP 2002309528 A **JP 2001064921 A**
JP 2000262864 A **JP 2000254517 A**
US 20040224147 A1 **US 20020160913 A1**

(58) Field of Search:
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(54) Abstract Title: **Photocatalytic NOx removing screen**

(57) A decorative photocatalytic screen 100 for the de-pollution of air, wherein a photocatalyst is applied as coating or dispersed in the material out of which the screen is made. The screen is preferably for use close to sources of air pollution, in such spaces as car parks, tunnels, and street canyons, or other spaces characterised by high levels of air pollution and low levels of UV-light required for the photo-catalytic effect. The screen contains a distribution of voids 103-105 and is mounted with enough distance from existing surfaces to result in a screen permeable to light and polluted air. The surface area of the screen may be increased by means of fins, ridges, dimples, holes or by the use of foams, aggregates, webs, weaves or felts. The decorative quality provides an additional incentive for the use of such screens in public spaces serves as an expression of photo-catalytic de-polluting technology for educational, marketing, and PR applications. The photocatalyst may comprise Titanium Dioxide (TiO_2) for the reduction of Nitrous oxides (NOx).

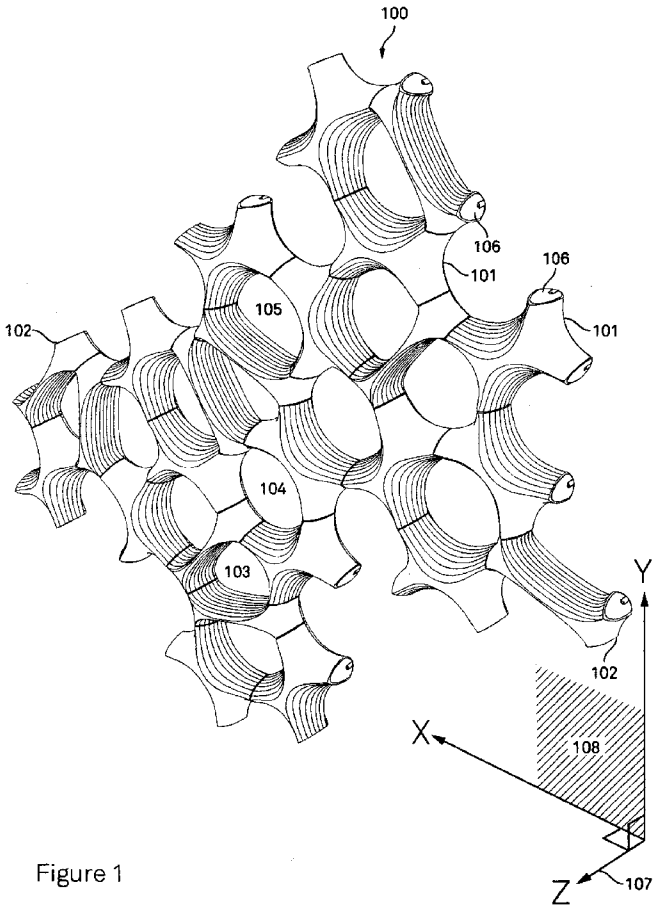

Figure 1

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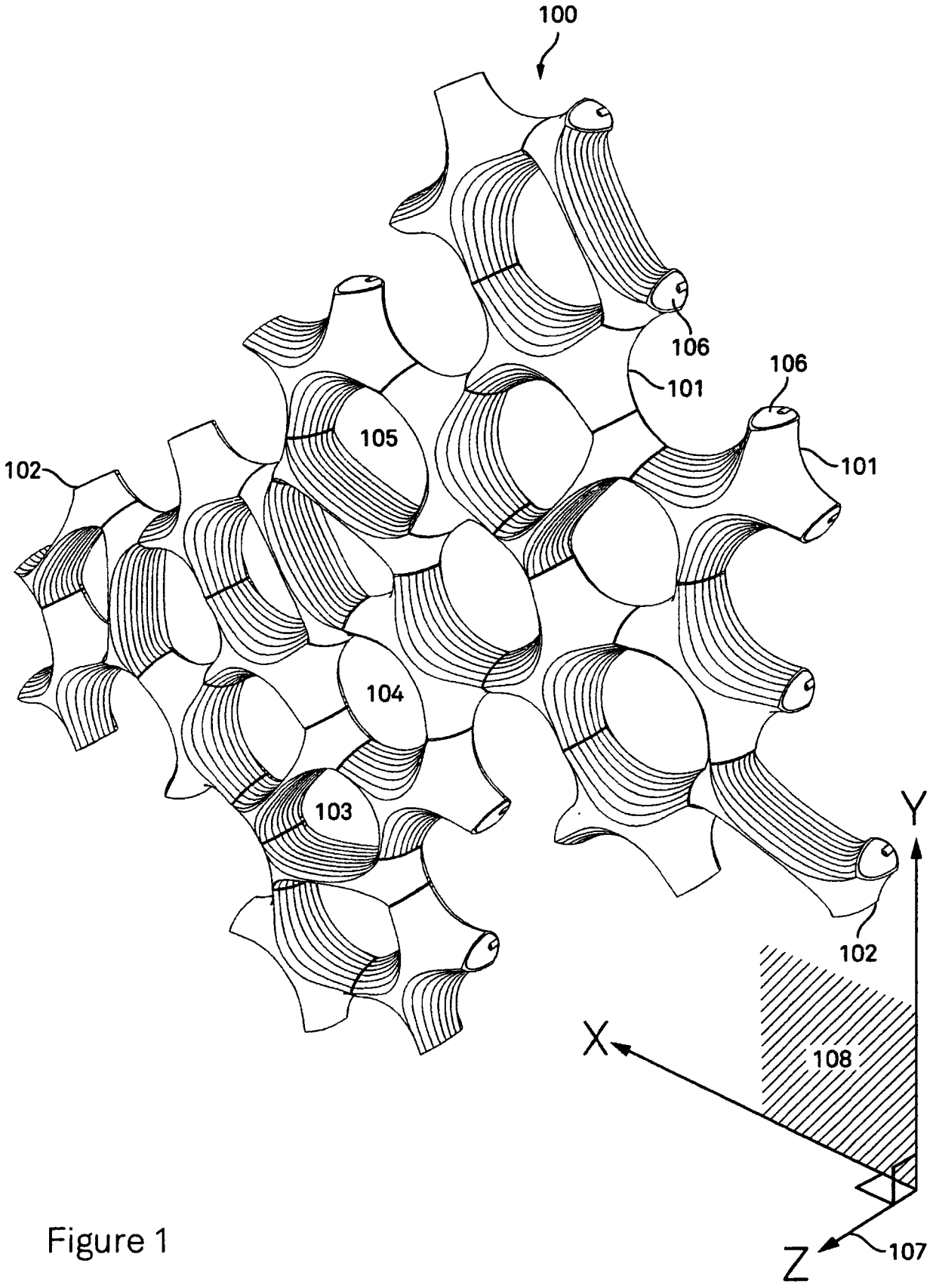


Figure 1

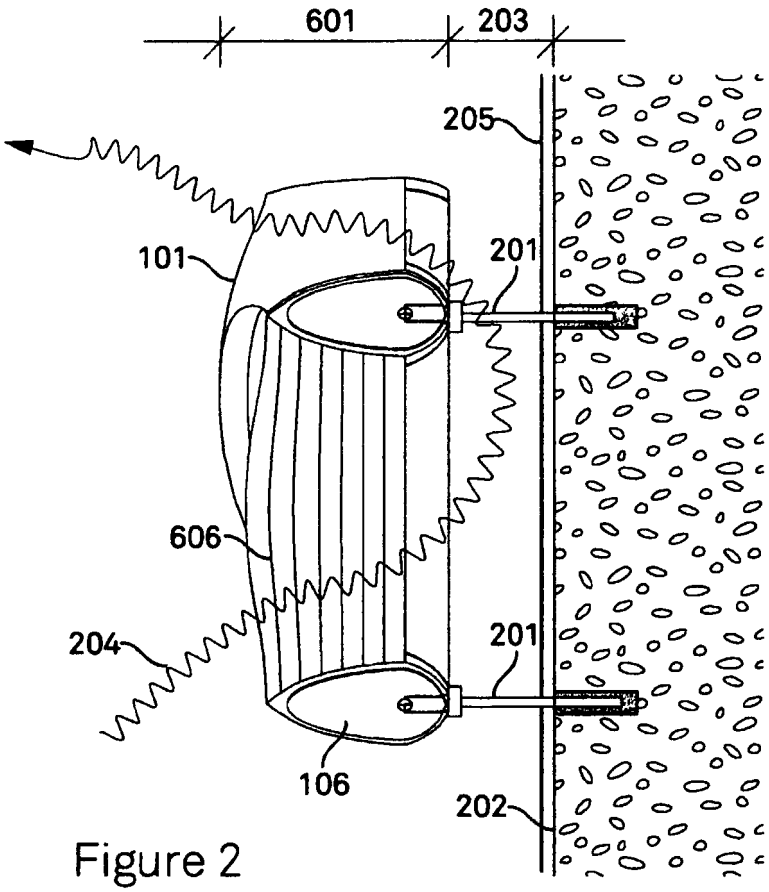


Figure 2

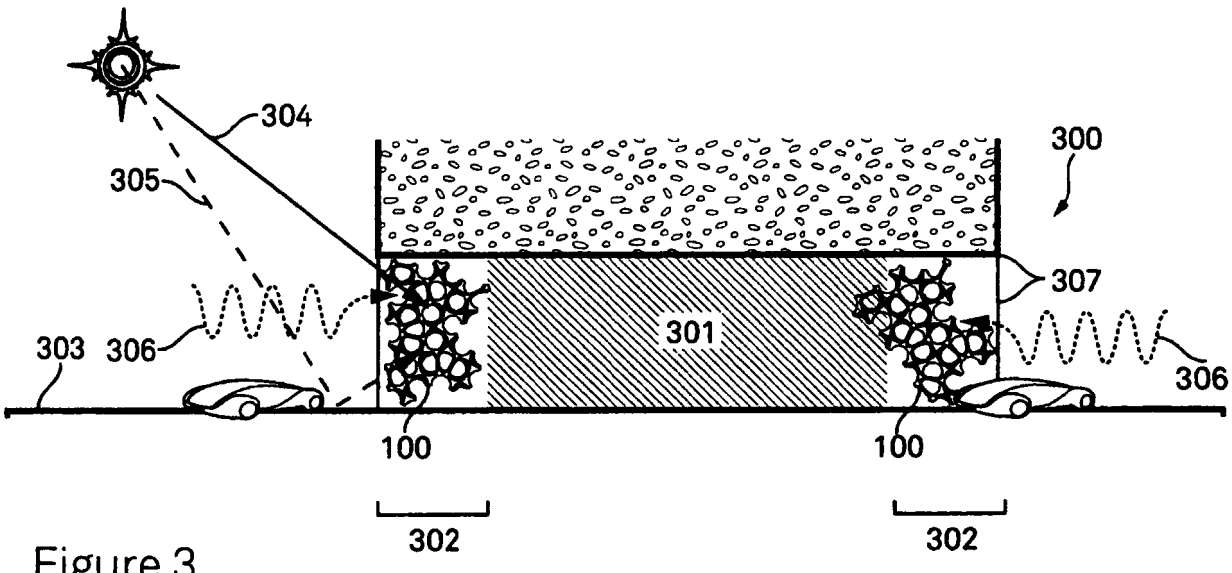
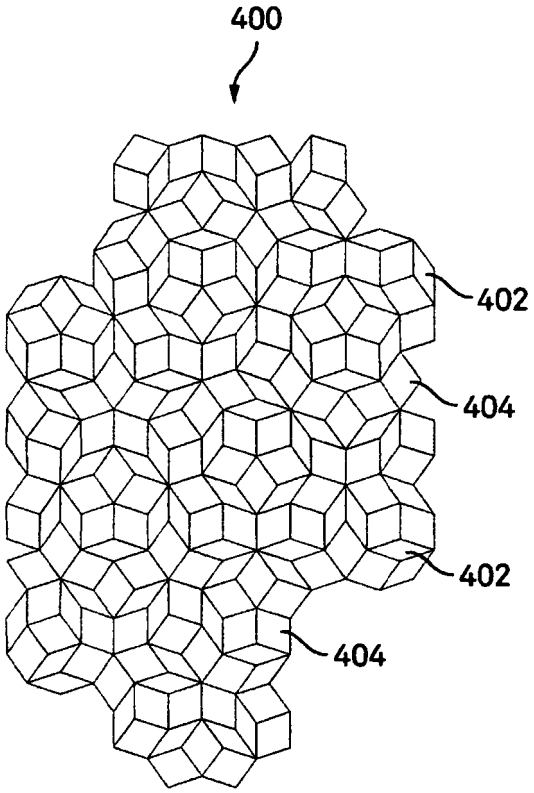


Figure 3



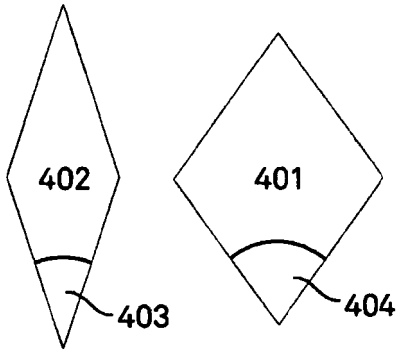


Figure 4

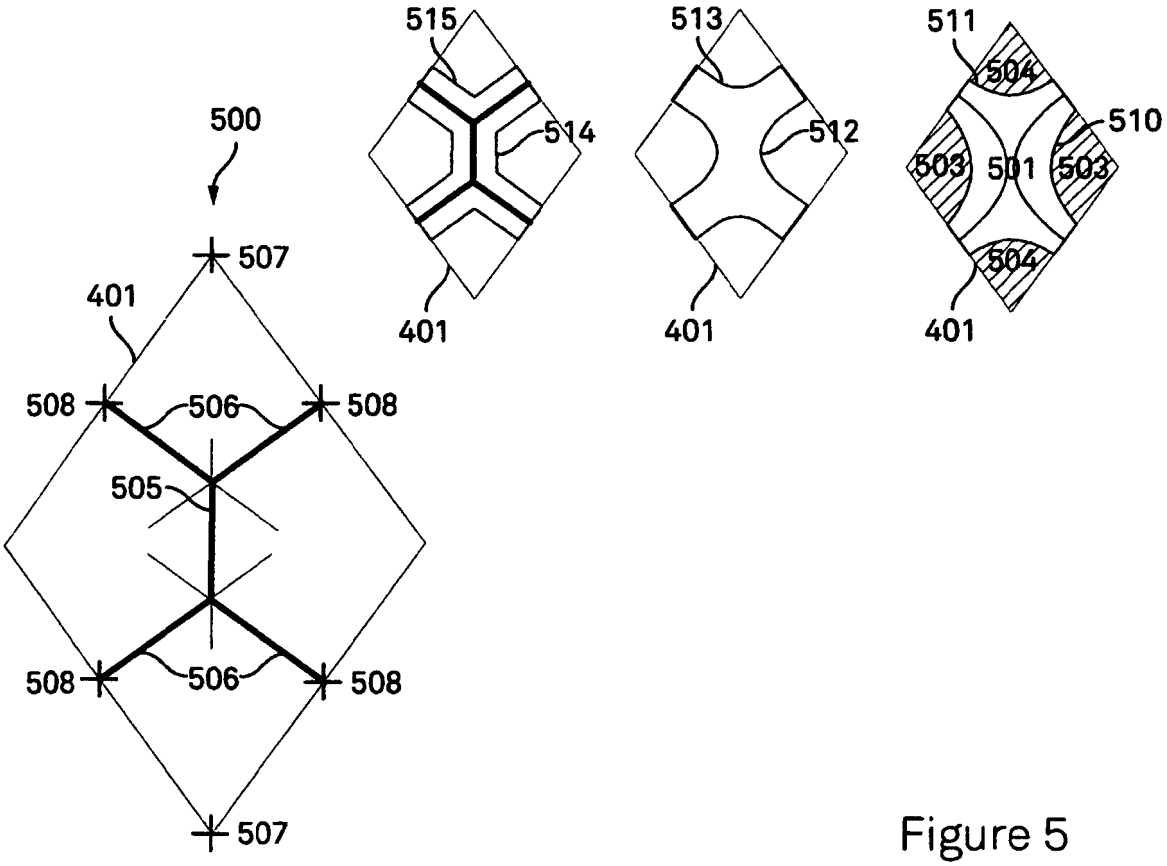


Figure 5

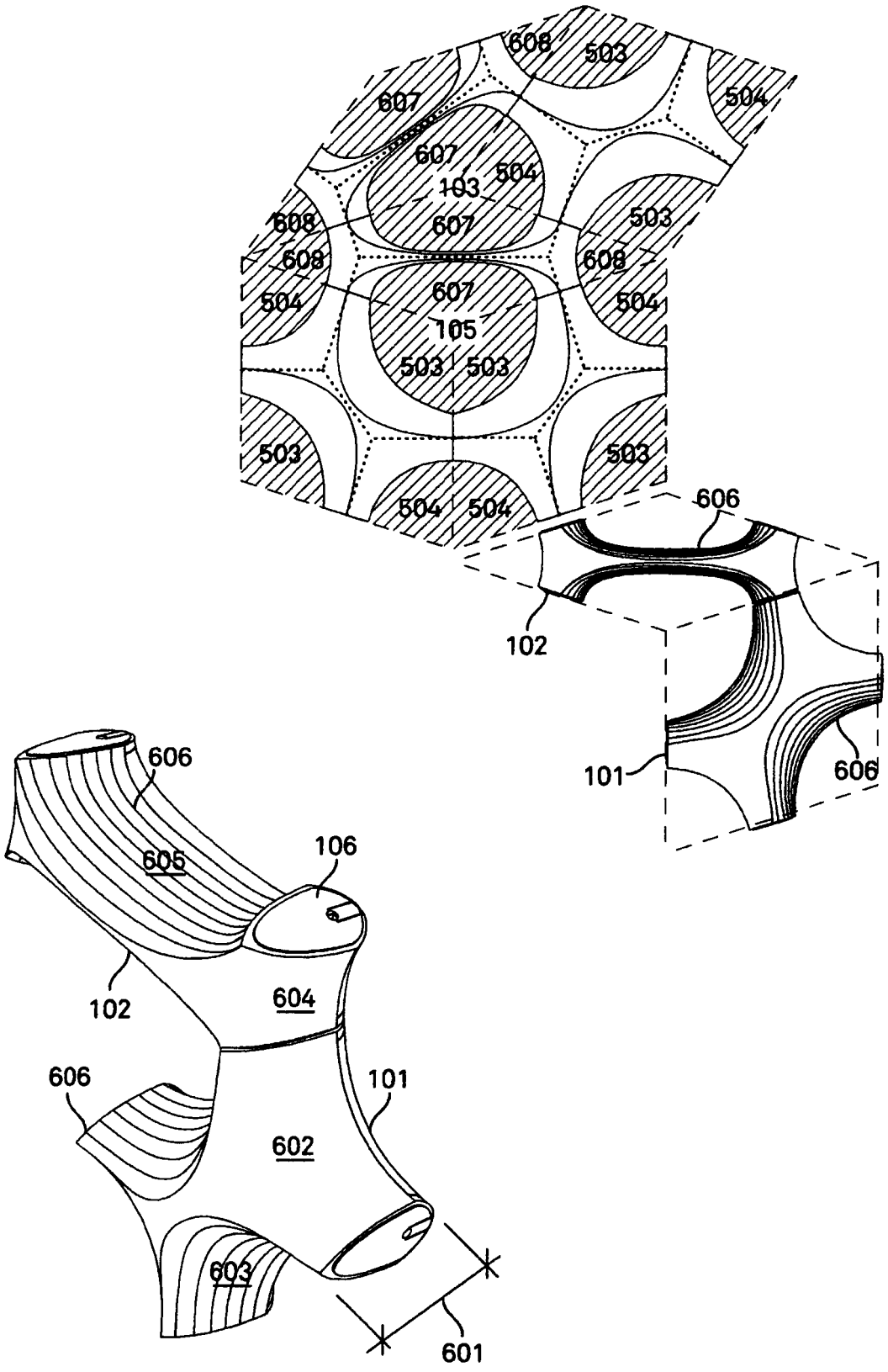

608
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Figure 6

NO_x REMOVING SCREEN

Field of Invention

The present invention relates to an apparatus for the reduction of air pollution in built-up areas - specifically by targeting anthropogenic airborne NO_x, as a pollutant and as a precursor to other pollutant substances

Background of the Invention

In built-up areas, high concentrations of air pollution meet high population densities. Cities and built-up areas are one of the biggest contributors to air pollution. Half the world's population lives in cities. The largest part of this anthropogenic pollution from built-up areas is caused by vehicular traffic. In towns and cities, Nitrous oxides (NOx), volatile organic compounds (VOC), fine particulate matter, sulphur, and ground level ozone draw the biggest concern. Their economical impact, predominantly in the form of health care costs and reduced productivity, but also in damaging buildings, is well documented This provides an economic incentive for methods that reduce such pollutants, as presented by this invention.

It has already been proposed the use of certain photo-catalysts such as nano-sized or superfine TiO2 in construction materials and coatings, for the reduction in built up areas of Nitrous oxides (NOx) and other atmospheric contaminants suitable for decontamination by TiO2. Thus, there are already available materials which integrate de-polluting TiO2 with common construction materials, such as paints and coatings, glass, concrete block or paver, brick, or road surfacing. It is obvious that the most effective use of such materials is in proximity to high concentrations of atmospheric pollution and where they are created, thereby removing pollutants before they can harm humans or escape into the wider atmosphere. Patents WO2005082810, JP10158079 describes make-up and advantages of such materials.

However, the use of photo-catalytic TiO2 as paint or other forms of coating has the following disadvantage. The photo-catalytic reaction requires small amounts of UV-light. As mentioned above, photo-catalytic de-pollution has its greatest effect in spaces with high pollution concentrations. These spaces by nature exhibit a degree of enclosure which traps and accumulates pollution It is this degree of enclosure that also prevents daylight from entering deep into these spaces, rendering large areas unsuitable for photo-catalytic de-pollution. With only a limited area suitable for photo-catalytic reaction, and the application of paint and coatings limited to existing, and commonly flat, two-dimensional surfaces, the effect of photo-catalytic de-pollution in its current applications is severely reduced where it is most needed. It is an additional quality of such pollution trapping, enclosed spaces to be dark, uninhabitable and inhumane in appearance, often as a result of the presence of pollution. Current renditions of photo-catalytic building materials do not directly address this.

The use of photo-catalytic TiO2 in applications that integrate it into common building materials such as concrete block or paver, brick, or road surfacing has similar disadvantages as found in coatings, as they again present only two-dimensional applications, with only one side of the unit available for photo-catalytic activity.

Some of the disadvantages concerning surface area are addressed in JP10158079, where a rough concrete block is used specifically for its property of offering a rough, undulating surface, thereby increasing the area of photo-catalytic activity to an extent. While such applications are entirely conceivable in highly polluted spaces that are constructed anew, their use for the adaptation of existing tunnels is cumbersome, requiring highly invasive construction, often not justifying their use over simple coatings, which can be

applied more easily and with only slight disadvantages in terms of surface areas. Moreover, while offering some surface enlargement, this enlargement is again restricted to one side or surface of the unit, thereby presenting only a limited improvement on previously mentioned applications such as coatings or masonry.

It is a further disadvantage of current applications of photo-catalytic technology intended for architectural conditions to have as their design objective the visual integration of photo-catalytic agents into existing and known materials and methods, thereby ensuring the inconspicuousness of this new technology since the photo-catalytic material is indistinguishable from the common building material. Such inconspicuous applications:

A) lack the potential to educate the public about the availability of such effective new green technologies and environmentalism in general

B) fail to signal that previously uninhabitable spaces have been rendered inhabitable and safe for pedestrian or other human use

C) by creating invisible applications, ignore the potential of photo-catalytic de-pollution technology as a vehicle for public relations or marketing for the bodies investing in de-polluting technology, such as local governments or private bodies

D) by remaining invisible, fail to create an increased sense of ownership in environments in terms of air quality improved, and aesthetically

Synchronously, there is a growing awareness about the existence of a relationship between quality of public space, and rates of crime. Local and regional governments are making significant investments to ameliorate the aesthetic appeal of derelict neighborhoods and areas for the sake of reducing levels of crime, increasing sense of ownership and quality of life, and/or drawing investments to communities and cities.

Object of the Invention

Accordingly, it is an object of this invention to overcome at least one of these disadvantages and to provide a solution by devising an installation that maximises the efficacy of de-polluting coatings or composite materials.

Another object of the invention is to imbue such an installation serving as a solution to the problem of air pollution in built-up areas with such aesthetic qualities so as to provide an additional incentive for the use of the de-polluting technology in those spaces displaying highest concentration of contaminants which can be targeted by said de-polluting technology, which simultaneously require visual improvement, and to provide visual expression of photo-catalytic technology where it is otherwise desirable, and to provide such an aesthetic configuration, which simultaneously possesses properties favourable for conditions required for photo-catalysis with TiO2.

Summary of the Invention

There is disclosed in this invention a device for the use in built-up areas, specifically in those spaces of said areas which suffer from high levels of air pollution, to remove these atmospheric pollutants from the air, and to provide the additional incentive for the use of this installation of being aesthetically pleasing, so as to visually improve a polluted space and to form a visual expression of the presence of de-polluting technology.

The photo-catalytically active components of said screens or installations made of plastic, concrete, wood, metal, or any other appropriate material, providing either a substrate for photo-catalytic coatings as described in WO2005082810, or consisting of a composite material in which similar photo-catalytic TiO2 is dispersed to create a composite which performs as the previously mentioned coating, said components produces by any method or process of manufacturing such as moulding, forming, casting, or cutting.

Said screens mounted at a distance to any existing surfaces by means of spacers or ties, and also displaying a distribution of voids, permitting for the circulation of air and light around all surfaces of the installation with photo-catalytic activity, these voids also permitting light to reflect off any surface covered by said installation back onto said screen.

This screen to display an assembly of solid and aforementioned voids, these voids formed and defined by solids displaying depth so as to create additional surfaces along the axis creating depth, said surfaces surrounding and forming the voids, these additional surfaces thereby possessing an orientation perpendicular or at an angle to the primary plane of the screen's construction, thereby increasing the number of surfaces and the total amount of surface area and creating various angels of incidence of light exposure in the screen.

Said additional surfaces to be either convex, concave, or folded, or displaying any other surface property, these surfaces further enlarged by displaying a secondary level of surface complexity such as folded, crumpled, dimpled, finned, or foamed, chipped, scored, or etched, or any other way of increasing surface area by geometric means or by means of material process, thereby ensuring surface enlargement of photo-catalytic material close to the voids through which polluted air circulates and passes

Preferably, theses voids to display morphological variation and irregularity in distribution, where any shape is conceivable for these voids, such as round, ovoid, square, or polygonal.

Preferably, such screens may be modular, consisting of one, two or more constituent parts or modules forming the solid areas of the screen, thereby forming the structure of the screen, these solids connected by repetitive joints, as in a modular system, with known economic advantages, allowing for cost efficient production, said solid constituents creating or incorporating the voids.

Preferably, these constituent solid parts forming, containing, or partially containing the voids, derived from the constituent shapes, rhombs, or polygons of an irregular pattern or tiling possessing no translational symmetry or periodicity, but possessing modularity of some kind, as found in the geometry of quasi-crystals, such as a five-fold symmetric Penrose pattern consisting of two base shapes or tiles, or any other method which results in a satisfactory solution in terms of aesthetic appeal, increased efficacy and economic viability, so as to allow for:

A) an increase of surfaces and area of surfaces imparted with photo-catalytic activity

B) the flow of contaminated air around the entirety of this new installation and its said photo-catalytic surfaces, except for faces where constituting parts are joined

C) the reflection of light from original surfaces onto any surfaces of the new installation which would otherwise not benefit from direct exposure or only diminished exposure, thereby multiplying surface area receiving sufficient UV light exposure

D) an increase of surfaces or surface area exposed to UV-light in various and changing lighting conditions at any given moment as a result of this configuration's omni-directionality

E) the formation of an aesthetically pleasing configuration with the ability to bestow on a previously derelict area a visual improvement

F) the visual articulation of the presence of de-polluting technology, thereby signalling to occupants of such spaces with previously high pollution that the air is now safer to breathe, this visual articulation also being useful for educational purposes, marketing or public relations

G) easy installation and maintenance of constituent parts requiring replacement

Preferably, the aforementioned voids created by the assembly of constituent solid parts to display variation of shapes, these variant voids to be distributed in an apparent random, irregular fashion, their apparent random distribution and morphological variation made possible by deriving the constituent solid parts or modules from apparent random, irregular patterns possessing no translational symmetry or periodicity, such as a five-fold symmetric Penrose pattern, or any other means of creating apparent or authentic irregularity, this irregularity imparted on the overall distribution, orientation and shape of solids, and thereby on voids and thereby on the pattern as a whole.

Penrose patterns are named after Roger Penrose who investigated the geometry of point symmetric tiling systems or patterns which appear irregular and possess no translational symmetry or periodicity, while consisting of only a few constituent parts.

Preferably, the solids created by subdividing such a rhomb or polygon making up a Penrose or similarly non-repetitive pattern into solids and voids, this configuration resembling in diagram a bone or a leaf structure, consisting of a mid-rib of any diameter, oriented along the line connecting two opposite vertices of the polygon, the mid-rib bifurcating at each end, before reaching the vertices, into lateral veins of any diameter, connecting to the midpoints of each side of the rhomb, preferably perpendicular to the lateral sides to create a continuous effect at the joint conditions, a similar method applied to all other rhombs or polygons making up such a quasi-crystalline pattern, these voids communicating with voids of adjacent parts to shape larger voids, the solids connecting with adjacent solids for an effect which de-emphasizes the constituent parts and emphasizes the pattern.

Brief description of the Drawings

An example of a preferred embodiment will now be described by way of example with reference to the accompanying drawings wherein:

Figure 1 is a perspective view of a decorative de-polluting screen according to the preferred embodiments of the invention, also showing its plane of construction later used from reference.

Figure 2 is a schematic elevation view displaying how the installation is mounted to existing surfaces; per example of a single module.

Figure 3 is a schematic section a space particularly suitable for photo-catalytic de-pollution as presented by this invention

Figure 4 is a diagram depicting a Penrose pattern and its two constituent rhombs

Figure 5 is a diagram showing a method for deriving modules based on a Penrose rhomb; per example of the wider rhomb

Figure 6 depicts the interaction of solids and voids and a perspective view of the two solids used for a screen according to the preferred embodiments of the invention.

Description of the preferred embodiments

An example of a preferred embodiment will now be described by way of example with reference to the accompanying drawings wherein:

The screen 100 useful for de-pollution comprises a number of voids 103-5 to allow air and light to pass through and around the screen 100 so as to expose all active surfaces of said screen to polluted air and to direct, ambient, reflected, or reflected ambient light.

Ideally, said screen 100 is mounted in a space 300 favourable to the accumulation of air pollution, this space featuring an enclosure 307 close to a traffic way 303, where levels of direct 304, ambient 306, reflected 305, or reflected ambient light are sufficiently present at the margins 302 of such spaces, but insufficiently present in dark spaces 301 lying further inward and away from light sources.

The permeability of the assembly 100 to light and air through the voids 103-5 is enhanced further by mounting the assembly 100 at some distance 203 to existing surfaces 202 by use of spacers 201, to allow a photo-catalytic coating to be applied to existing surfaces 202, thereby increasing overall area of active surfaces, allowing the circulation of polluted air 204 around all active surfaces of the new installation and newly coated existing surfaces.

In a preferred embodiment, the assembly 100 is modular, consisting of only two constituent solids 101 102, featuring congruent joints 106, and forming voids of various shapes 103 104 105, depending on which combination and orientation of constituent modules 101 102 make up these voids, the distribution and orientation of these voids appearing to be irregular, aperiodic and non-translational.

In a preferred embodiment, an irregularity is imparted on the assembly 100 by a derivative method of conceiving geometry of assembly 100 from a pattern 400 possessing no translational symmetry or periodicity, such as in this preferred embodiment a five-fold symmetric Penrose pattern, this pattern itself made up of constituent polygons or rhombs 401 402, one wide 401 and one skinny 402, with acute angles of 36 degrees 403 and 72 degrees 404, respectively, these constituent two-dimensional rhombs then serving as a design template 500 for three-dimensional modules 101/102, conceived as derivatives of Penrose rhombs 401/402, whereby said rhombs are subdivided into solid areas 501 and voids 503/504 and 607/608, defining various shapes and orientation thereof of voids 103-105.

In a preferred embodiment, the solid area or volume of modules 101/102 of assembly 100 is conceived by the following method, shown per example of the wider tile 401, the same or comparable method applied to the narrow tile 402:

- a line 505 is drawn partially along the line connecting the two vertices 507 furthest apart from each other

- lines 506 are drawn inward from the midpoints 508 of the rhombs' sides at an angle perpendicular to the sides

- midline 506 has its beginning and end in the points formed by the intersection of lines 506 with themselves and with midline 505; the resulting shape resembles a letter h with its ends pointing outwards

- the vertices created by above method are used directly to devise a three dimensional form by offsetting the lines 505 and 506 to create a shape defined by lines 514/515, or as vertices for derivative curves or splines 510/511 of 2nd, 3rd, or nth degree, or as filleted version 512/513 of

straight lines 514/515. and then giving this shape three-dimensional extension by extrusion, or any other method

Referring to Figure 6, the ratio of solid to void is governed only be structural requirements and requirements of surface enlargement of assembly 100 and can otherwise be of any desired proportion.

These solids display depth 601 in a Z direction 107 perpendicular to the primary plane of construction XY 108 shown in Figure 1, resulting in surfaces 602-605 that are at an angle to the XY plane108 of assembly 100 with orientation anywhere from parallel to perpendicular to the plane XY.

These surfaces 602-605 featuring ridges 606 to create a secondary level of surface enlargement, although surface enlargements of various kind, such as folded, crumpled, dimpled, finned, or foamed, chipped, scored, or etched are conceivable and are not limited to said surfaces 602-605, but may be used to enlarge any surface that is part of the installation that is photo-catalytically active.

The embodiments described above are provided by way of illustration only and should not be seen to limit the invention. Those skilled in the art will readily recognize various modifications and changes may be made to the present invention without departing from the true spirit and scope of the present invention. Accordingly, it is not intended that the invention be limited, except as by the appended claims.

Claims

1 A decorative, de-polluting installation used in places with high concentrations of air-pollution, comprising.

a decorative, three-dimensional screen for de-pollution comprising a plurality of voids defined by surrounding solid areas, coated in de-polluting material or created from a material which is imparted with de-polluting properties, displaying a distribution of voids to allow required light and polluted air to reach all exposed surfaces and existing surfaces not part of the assembly and to which the assembly is mounted, connected to said existing surfaces by spacers or wall ties, allowing the installation of the structure at some distance from the original tunnel surface, for the same previously mentioned reasons.

2. The installation of Claim 1, where said installation displays extension not only in directions XY of primary construction plane, but also in a direction Z perpendicular to said construction plane, so that it may be described as being three dimensional, as in an extrusion, where a two-dimensional outline or shape is extruded along an axis perpendicular to the orientation of the original shape, thereby creating new additional surfaces or faces where there had previously been lines, although the method of creating this extension should not be limited to the method of extrusion, which is here only used as an illustration

3. the voids of Claim1, where the extension in three-dimensions of Claim 2 creates additional faces around said voids through which contaminated air passes

4. the faces of Claim 3 surrounding the voids of Claim 1 itself further enlarged by means of geometry, such as fins, ridges, dimples, holes, perforations, or by means of process, such as foams, aggregates, webs, weaves or felts

5. the surfaces of Claim 4 where said surface enlargements result in an increase in surface area coming into contact with polluted air

6 the screen of Claim 1, where the arrangement of voids and structure is of an apparently random or random appearance

7. The installation of Claim 1, wherein voids vary in shape, orientation and distribution

8 The installation of Claim 1, wherein voids are constant in shape and orientation, but not in distribution

9. the installation of Claim 1, wherein the faces of Claim 3 create multi-facettedness and omni-directionality

10 A decorative, de-polluting installation used in places with high concentrations of air-pollution, comprising:

decorative, three-dimensional modules making up a screen for de-pollution comprising a plurality of voids defined by said modules or contained thereby, these modules coated in de-polluting material or created from a material which is imparted with de-polluting properties, the resulting screen displaying a distribution of voids to allow required light and polluted air to reach all exposed surfaces and existing surfaces not part of the assembly and to which the assembly is mounted, connected to said existing surfaces by spacers or wall ties, allowing the installation of

the structure at some distance from the original tunnel surface, for the same previously mentioned reasons.

11. The modules of Claim 8, their three dimensional extension increasing overall surfaces area of the screen

12 The modules of Claim 10 where exterior surfaces or any other surface coming into contact with polluted air are enlarged by means of geometry, such as fins, ridges, dimples, holes, perforations, or by means of process, such as foams, aggregates, webs, weaves or felts.

13. The modules of Claim 11, where said enlarged surfaces result in an increase in surface area coming into contact with polluted air

14. the modules of Claim 10, with only one type of joint

15. the modules of Claim 10, where the arrangement of voids and structure is of an apparently random, or random appearance

16. The modules of Claim 10, which create voids that vary in shape, orientation and distribution

17. The modules of Claim 10, which create voids that are constant in shape and orientation, but not in distribution

18. the modules of Claim 10, wherein the faces of Claim 3 create multi-facettedness and omni-directionality

19. A decorative, de-polluting installation used in places with high concentrations of air-pollution, comprising:

    a decorative, three-dimensional screen made up of screens of Claim1, or of screens made up of modules of Claim 9, or a combination of both, for de-pollution comprising a plurality of voids defined by surrounding solid areas, coated in de-polluting material or created from a material which is imparted with de-polluting properties, displaying a distribution of voids to allow required light and polluted air to reach all exposed surfaces and existing surfaces not part of the assembly and to which the assembly is mounted, connected to said existing surfaces by spacers or wall ties, allowing the installation of the structure at some distance from the original tunnel surface, for the same previously mentioned reasons

20 An installation substantially as herein described above and illustrated in the accompanying drawings

Intellectual Property Office (IPO)

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Application No: GB0616749.8 **Examiner:** Heather Webber

Claims searched: all **Date of search:** 11 December 2007

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	all	JP 2000262864 A (FURUKAWA ELECTRIC CO et al) see WPI abstract accession number: 2001-083918 [10] and figures
X	all	JP 2002309528 A (NIPPON STEEL METAL PROD) see WPI abstract accession number: 2003-024098 [02] and figures
X	all	JP 2001064921 A (SEKISUE JUSHI KK) see WPI abstract accession number: 2003-024098 [02] and figures
X	all	US 2002/0160913 A1 (SANGIOVANNI et al) see especially paragraphs [0004 - 0013] and figures
X	all	US 2004/0224147 A1 (CHOU) see whole document
X	1 - 3, 6 - 11 & 14 - 19	JP 2000254517 A (SUMITOMO PRECISION PROD CO) see WPI abstract accession number: 2001-027355[04] and figures

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art
Y	Document indicating lack of inventive step if combined with one or more other documents of same category	P	Document published on or after the declared priority date but before the filing date of this invention
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{X} :

Worldwide search of patent documents classified in the following areas of the IPC

B01D; B01J; B44B; B44C; B44D; B44F; E01C; E01F; E04B; E04C

The following online and other databases have been used in the preparation of this search report

EPO, WPI, GOOGLE

International Classification:

Subclass	Subgroup	Valid From
B01J	0035/00	01/01/2006
B01D	0053/86	01/01/2006
E01C	0001/00	01/01/2006