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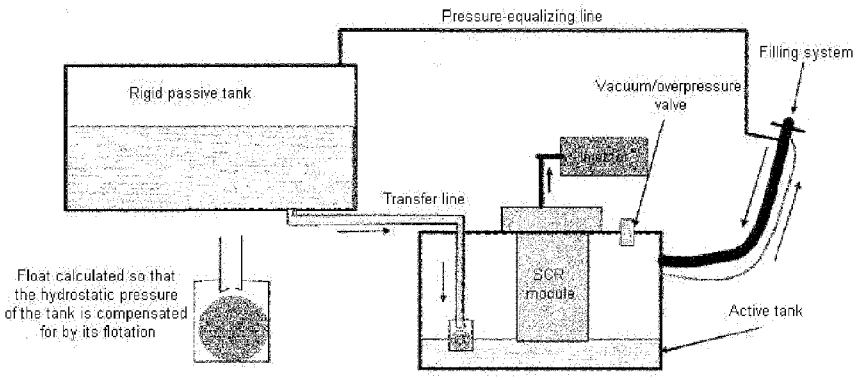
(54) **Title**: SCR SYSTEM FOR AN INTERNAL COMBUSTION ENGINE

Figure 2



(57) **Abstract**: SCR system for an internal combustion engine comprising a first tank (1) and a second tank (2) equipped with a venting system, located at a level below that of the first tank (1) and that may be gravity filled with liquid originating from the first tank (1), according to which the passage between the two tanks is equipped with a device that closes off said passage under the effect of the hydrostatic pressure of the liquid of the first tank (1) and that only opens up said passage when the level of liquid in the second tank (2) is below a setpoint level.

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SCR system for an internal combustion engine

The present application relates to an SCR system for an internal combustion engine.

With the Euro IV standard on exhaust emissions from heavy goods vehicles coming into effect in 2005, devices for NO_x (or nitrogen oxides) pollution control have had to be put in place.

The system used by most manufacturers of heavy goods vehicles for reducing NO_x emissions to the required value generally consists in carrying out a selective catalytic reaction with reducing agents such as urea ("Urea SCR" or selective catalytic reduction using ammonia generated *in situ* in the exhaust gases by an ammonia precursor, for example by decomposition of a urea solution).

In order to do this, it is necessary to equip the vehicles with a tank containing this precursor, and also a device for metering the amount of this precursor to be injected into the exhaust line. For simplicity, the ammonia precursor will be referred to as "urea" in the remainder of the description, but it should be noted that other liquid precursors may be suitable.

For the purpose of increasing the driving range of the vehicles, and considering the encumbrance/structure of the vehicles, it is sometimes desired to have at least two tanks for storing the urea solution.

Urea systems with two tanks have already been proposed. Thus, patent US 5,884,475 describes the use of 2 urea tanks in series: one for storage, referred to as passive and one of smaller volume, referred to as active, which is heated and which is used for starting in the event of freezing. In one variant, the passive tank is located above the active tank so that the urea can be transferred by gravity from one tank to the other, which means that a transfer pump is not required.

Another practical case where the use of 2 tanks is advantageous is that where a second tank is attached to an existing SCR system so as to increase the driving range and, for example, so as to make it compatible with the minimum storage quantities required by the various legislations (12 litres in Europe compared to 24 litres in the United States for example). In this case too, the fact of having one tank above the other makes it possible to work without a transfer pump.

Generally, the active tank (or the tank of the pre-existing system) is provided with a venting system that makes it possible to avoid increases in pressure/vacuum and thus to avoid having to reinforce the tank mechanically and/or to provide overthicknesses. However, such a system can only operate below a maximum filling level of the tank. Therefore, the architecture with 2 tanks at different levels, presented as being advantageous above, can only operate with this type of vented tank on condition that a device is provided which makes it possible to prevent the upper tank from filling the lower tank beyond its maximum filling level.

This problem is, in particular, critical in systems where the upper tank is either vented (pressure-balanced), or consists of a flexible bag such as described in document WO 2010/078990 the content of which is, for this purpose, incorporated by reference in the present application.

Indeed, in the case of an unvented rigid upper tank, a vacuum will rapidly be created when liquid has flowed out so that there is no risk of complete drainage of the upper tank into the lower tank. It could therefore be imagined to provide a lower tank having a large dead volume (located above the maximum filling level) so as to be able to accommodate liquid from the upper tank without flooding the venting system, but this is obviously disadvantageous in terms of cost and encumbrance. With flexible bags and vented tanks on the other hand, given that there is no creation of a vacuum, a complete drainage of the upper tank into the lower tank is possible.

The present invention aims to solve this problem and to provide an SCR system having an architecture with 2 tanks located at different levels, the upper tank of which makes it possible to gravity fill the lower tank while enabling the latter to be efficiently vented.

For this purpose, the present invention relates to an SCR system for an internal combustion engine comprising a first tank (1) and a second tank (2) equipped with a venting system, located at a level below that of the first tank (1) and that may be gravity filled with liquid originating from the first tank (1), according to which the passage between the two tanks is equipped with a device that closes off said passage under the effect of the hydrostatic pressure of the liquid of the first tank (1) and that only opens up said passage when the level of liquid in the second tank (2) is below a setpoint level.

The present invention may be applied to any internal combustion engine. It is advantageously applied to diesel engines.

The liquid concerned by the present invention is an ammonia precursor, and preferably urea. The term "urea" is understood to mean any, generally aqueous, solution containing urea. The invention gives good results with eutectic water/urea solutions for which there is a quality standard: for example, according to the standard DIN 70070, in the case of the AdBlue® solution (commercial solution of urea), the urea content is between 31.8% and 33.2% (by weight) (i.e. 32.5 +/- 0.7 wt%) hence implying an available amount of ammonia between 18.0% and 18.8%. The invention may also be applied to the urea/ammonium formate mixtures, also in aqueous solution, sold under the trade name Denoxium™ and of which one of the compositions (Denoxium-30) contains an amount of ammonia equivalent to that of the Adblue® solution. The latter have the advantage of only freezing below -30°C (as opposed to -11°C), but have the disadvantages of corrosion problems linked to the possible release of formic acid and a less available market (whereas urea is widely used and readily available even in fields such as agriculture). The present invention is particularly advantageous in the context of eutectic water/urea solutions.

According to the invention, the liquid is held in tanks (1) and (2) which may be made from any material, preferably one having good chemical resistance to the liquid in question. In general, this is metal or plastic. Polyolefins, in particular polyethylene (and more particularly HDPE or high-density polyethylene), constitute preferred materials, in particular in the case where the liquid is urea.

These tanks may be produced by any processing method known in the case of hollow bodies. One preferred processing method, in particular when the tanks are made of plastic, and in particular HDPE, is the extrusion-blow moulding process. In this case a parison (in one or more parts) is obtained by extrusion, and is then shaped by blow moulding in a mould. One-part moulding of the tank from a single parison gives good results.

According to a first variant of the invention, the two tanks are rigid. However, according to one preferred variant of the invention, the first tank (1) is a flexible bag as described above, whilst the second tank (2) has a rigid wall.

According to one advantageous variant of the invention, the first tank (1) is a flexible bag "taken" from a commercial packaging of an Adblue® solution consisting of a bag-in-box, i.e. a cardboard box comprising an inner flexible bag, generally of square/rectangular section.

Preferably, the second tank (2) is provided with a heating element.

This tank (2) is also advantageously provided with a base plate or mounting plate (i.e. a support having substantially the shape of a plate) onto which at least one active accessory of the urea storage system and/or injection system is attached. This base plate generally has a perimeter, closed up on itself, of any shape. Usually, its perimeter has a circular shape.

This base plate is generally attached to the upper wall or to the lower wall of the tank and it incorporates at least one active storage and/or injection component. This means that the component is attached to or produced as one part with the base plate. This component may be incorporated inside tank (2), or outside of it with, if necessary, a connection (delivery tube) passing through it.

Preferably, the base plate according to this variant of the invention incorporates several active storage and/or metering components and, very particularly preferably, it incorporates all the active components which are in contact with the liquid additive found in, coming out of or going into tank (2).

Preferably, the component is chosen from the following elements: a pump; a filter; a level gauge; a temperature sensor; a quality sensor; a pressure sensor and a pressure regulator. It is advantageous for the feed pump to be incorporated into such a base plate and for this base plate to also incorporate other active components (preferably all the active components) as defined above.

Generally, the second tank (2) comprises a fill pipe whilst the first tank (1) is in fact a make-up tank that is attached to or brought into contact with the second tank and it does not necessarily have to have a fill pipe (since it is somewhat like a reserve/make-up cartridge).

When the first tank (1) is rigid, it is preferable to either to vent it, or to add a pressure-equalizing line that opens, for example, into the fill pipe. When it is flexible on the other hand, it is possible to work without such arrangements.

According to the invention, the passage between the two tanks is equipped with a device that closes off said passage under the effect of the hydrostatic pressure of the liquid of the first tank (1) and that only opens up said passage when the level of liquid in the second tank (2) is below a setpoint level.

The term "passage" may be understood to mean a simple opening, but preferably it is a pipe, and preferably a pipe connected to a hole in the bottom of the first tank (1) and comes out substantially in the bottom of the second tank (2) also. Hence, preferably, the closure device is also located in the bottom of this pipe and therefore, in the bottom of the second tank (2) so that the setpoint level is close to the bottom (almost empty) level of this tank.

In one variant of the invention, the closure device comprises a float (optionally firmly attached to a recall device, such as a spring) that is calibrated so that its flotation can compensate for the hydrostatic pressure due to the liquid in the first tank (1), even when the latter is full.

Appended Figures 1 to 3 illustrate preferred variants of the invention which are in no way intended to restrict the scope thereof.

Figures 1 and 2 relate to a same variant with a rigid first tank (1), and they illustrate the fact that the float opens up the transfer pipe (line) as soon as the level of liquid in the tank (2) drops below a certain level.

Figure 3 relates to a variant where the first tank (1) is a flexible bag. This bag is included in a cradle. Although it is illustrated laid flat, a variant according to which it is bag with a square/rectangular section placed on one tip and therefore inclined (preferably at 45°) gives good results in practice.

CLAIMS

1. SCR system for an internal combustion engine comprising a first tank (1) and a second tank (2) equipped with a venting system, located at a level below that of the first tank (1) and that may be gravity filled with liquid originating from the first tank (1), according to which the passage between the two tanks is equipped with a device that closes off said passage under the effect of the hydrostatic pressure of the liquid of the first tank (1) and that only opens up said passage when the level of liquid in the second tank (2) is below a setpoint level.

2. System according to the preceding claim, in which the liquid is a eutectic water/urea solution.

3. System according to any one of the preceding claims, in which the first tank (1) is a flexible bag and the second tank (2) has a rigid wall.

4. System according to the preceding claim, in which the first tank (1) is a flexible bag "taken" from a commercial packaging of an Adblue® solution consisting of a bag-in-box, i.e. a cardboard box comprising an inner flexible bag, generally of square/rectangular section.

5. System according to any one of the preceding claims, in which the second tank (2) comprises a fill pipe and in which the first tank (1) is a make-up tank that is attached to or brought into contact with the second tank (2).

6. System according to Claim 1 or 2, in which the first tank (1) has a rigid wall and is vented or is provided with a pressure-equalizing device.

7. System according to any one of the preceding claims, in which the passage between the two tanks comprises a pipe that is connected to a hole in the bottom of the first tank (1) and comes out substantially in the bottom of the second tank (2).

8. System according to the preceding claim, in which a liquid feed line comes out of tank (2) and a liquid return line goes into tank (2) and in which these lines are also provided with a heating element.

9. System according to the preceding claim, in which the closure device is located in the bottom of the pipe.

10. System according to Claim 8 or 9, in which the closure device comprises a float that is calibrated so that its flotation can compensate for the hydrostatic pressure due to the liquid in the first tank (1), even when the latter is full.

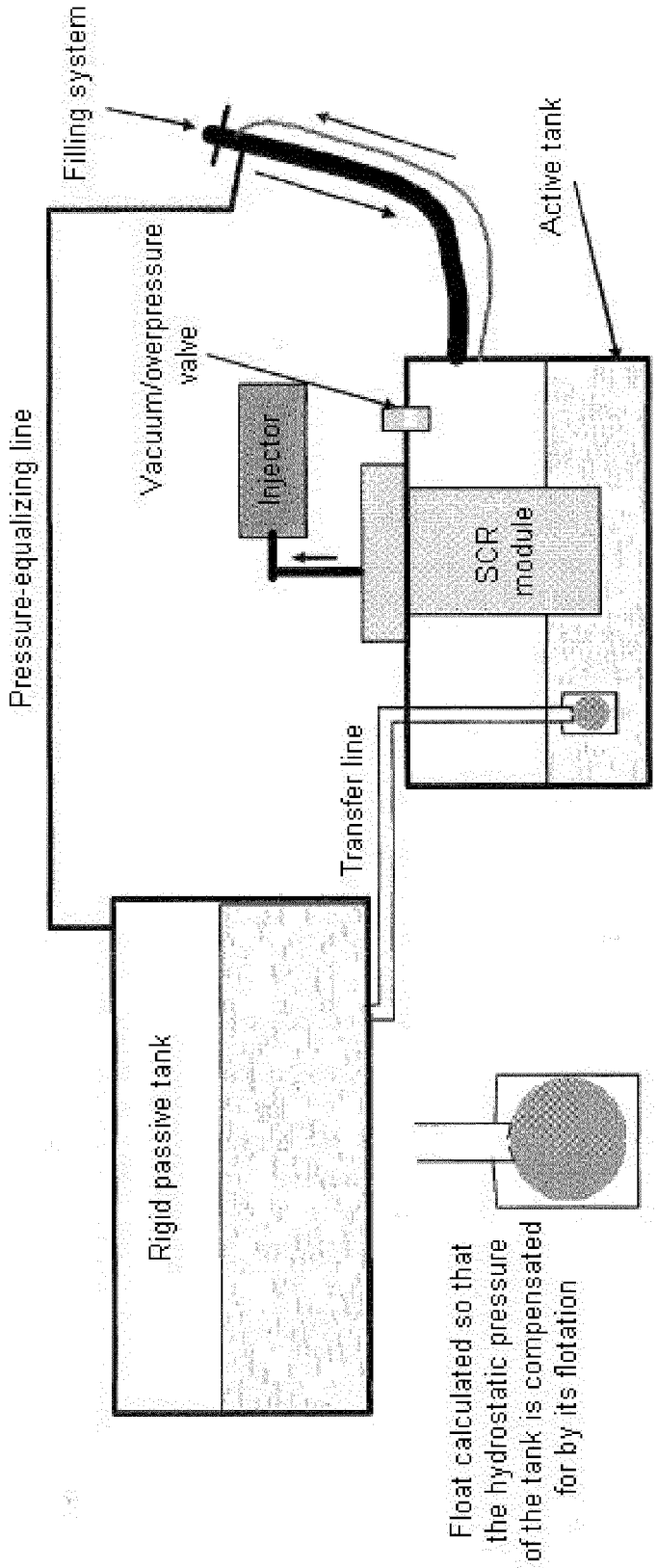
Filling system
Vacuum/overpressure valve
Injector
Pressure-equalizing line
Active tank
SCR module
Transfer line
Rigid passive tank
Float calculated so that the hydrostatic pressure of the tank is compensated for by its flotation

Figure 1

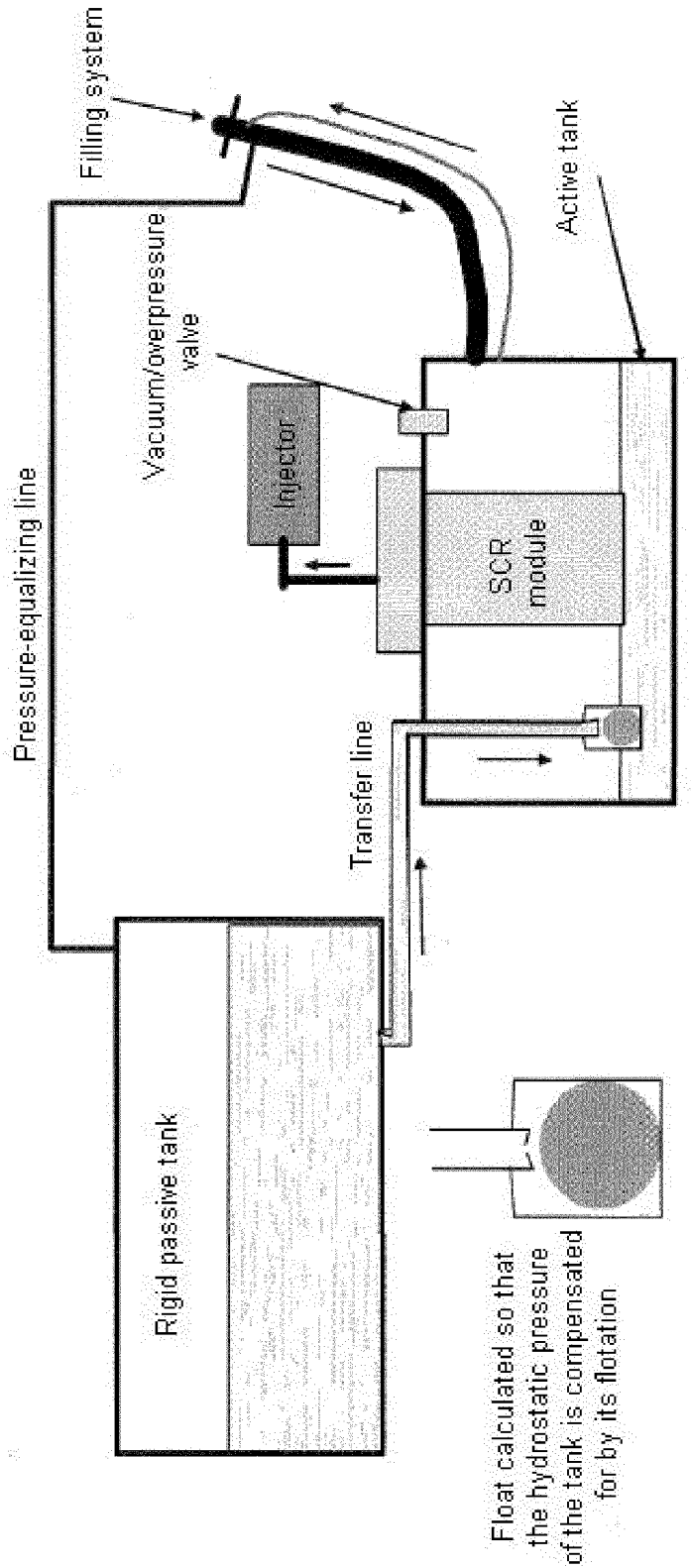
Filling system
Vacuum/overpressure valve
Injector
Active tank
SCR module
Pressure-equalizing line
Transfer line
Rigid passive tank
Float calculated so that the hydrostatic pressure of the tank is compensated for by its flotation

Figure 2

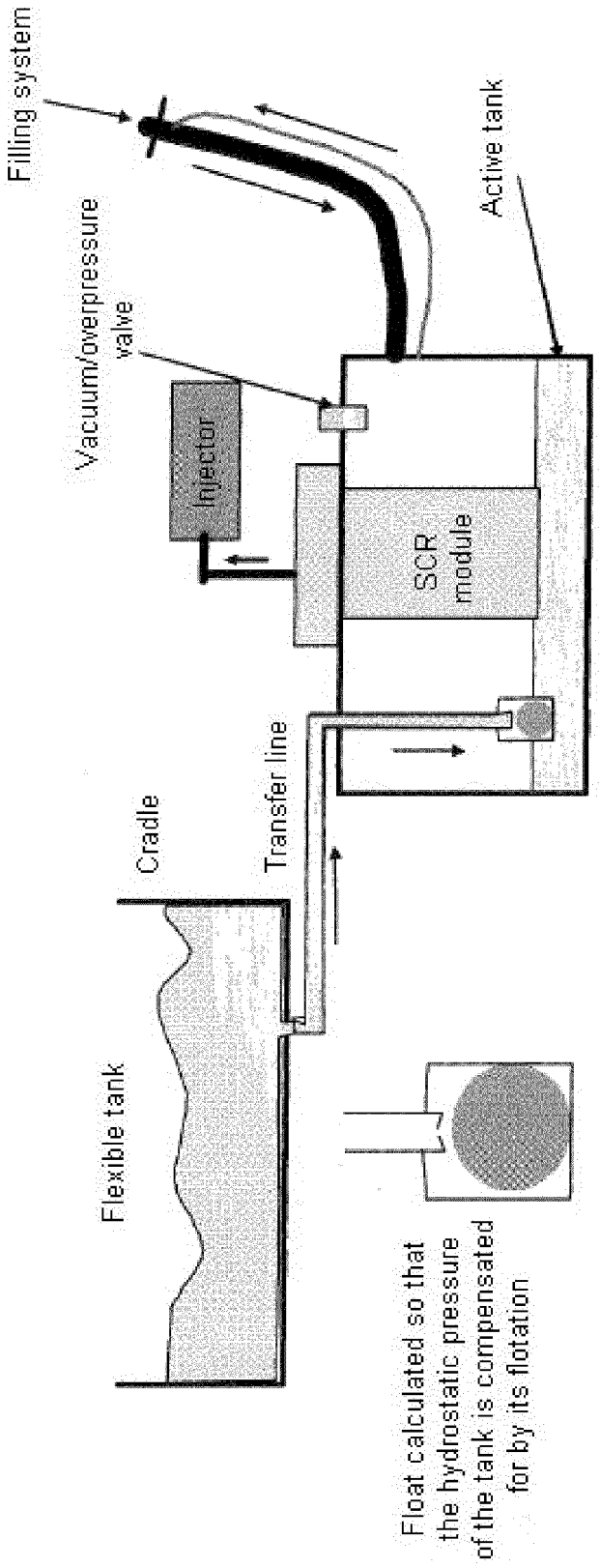
Filling system
Vacuum/overpressure valve
Injector
SCR module
Active tank
Transfer line
Cradle
Flexible tank
Float calculated so that the hydrostatic pressure of the tank is compensated for by its flotation

Figure 3

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2012/051495

A. CLASSIFICATION OF SUBJECT MATTER
INV. F01N3/20
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)
F01N B60K

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

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Y	EP 2 014 886 A1 (DELPHI TECH INC [US]) 14 January 2009 (2009-01-14) paragraphs [0053], [0054], [0056]; figures 11,13	3,4

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[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

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"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

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
24 February 2012	02/03/2012

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Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2012/051495

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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INTERNATIONAL SEARCH REPORT

Information on patent family members

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