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(54) **Vapour recovery regulation**

(57) A vapour recovery system for recovering fuel vapour from a vehicle tank (18) has a vapour recovery line (6) with a vapour pump (7) for transporting a stream of fuel vapour (V), and control means (2) for controlling the stream of fuel vapour (V). The vapour line (6) comprises

a temperature sensor (8) arranged for measuring a temperature (T) of the fuel vapour. The control means (2) determine how much a value representing the measured temperature (T) deviates from a reference value (T_{ref}) and determine a flow of fuel vapour in dependence of said deviation.

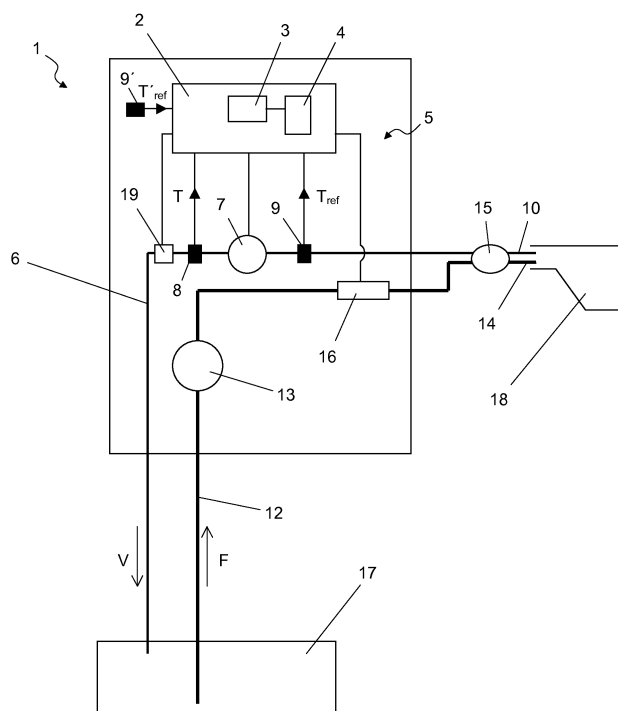


Fig. 1

Description

Technical Field

[0001] The present invention relates to a vapour recovery system, a fuel dispensing unit and a method for recovering fuel vapour from a vehicle tank during dispensing of fuel into the vehicle tank.

Background art

[0002] When filling the fuel tank of a motor vehicle, it is a common measure to recover the vapour escaping the tank when filling it with liquid fuel. This measure is taken for both safety and environmental reasons. The vapour recovery is achieved, for instance, by arranging a vapour suction nozzle next to the fuel dispensing nozzle of a pistol grip for filling the tank with fuel. Vapour is then removed from the tank during filling, at a certain rate, which is often controlled by the standard rate at which fuel is dispensed to the tank. Vapour recovery systems typically comprise a pump for feeding vapour, from the tank of the vehicle, to the fuel container from which fuel is fed to the vehicle. This mutual exchange of vapour/fuel is continuously performed when filling a vehicle with fuel.

[0003] Accordingly, it is quite important that the vapour recovery system operates properly. This means that there must be a flow of vapour when vapour shall be recovered, which is sometimes not the case when certain, relevant vapour recovery components malfunction.

[0004] Moreover, today some vehicles are fitted with an on-board refuelling vapour recovery (ORVR) system which vents the head space in the vehicle tank through a charcoal-filter, so that the vapour is absorbed by the charcoal.

[0005] A fuel dispensing unit fitted with a vapour recovery system but not able to detect vehicles equipped with ORVR systems, will waste energy and will ingest excessive air into the fuel container.

[0006] Today several techniques exist for detecting a flow of fuel vapour and/or if a vehicle is equipped with an ORVR system.

[0007] US-5,956,259, for example, discloses a fuel dispenser system configured to receive a signal from a vehicle transponder indicative of the presence of an ORVR system on the vehicle. If an ORVR equipped vehicle is detected, the fuel dispenser system deactivates its vapour recovery system.

[0008] WO 00/50850 discloses a fuel dispensing unit incorporating a vapour recovery system having a density detector for identifying the vapour composition of recovered vapour, and if the vapour is identified as substantially non-hydrocarbon (ORVR equipped vehicle) the operational rate of vapour collection is controlled accordingly.

[0009] A problem with existing fuel dispensers capable of detecting a flow of fuel vapour and/or ORVR equipped vehicles is that they are relatively complicated and ex-

pensive both in respect of construction and production.

Summary of the Invention

[0010] It is an object of the present invention to provide an improvement of the above techniques and prior art.

[0011] A particular object is to provide reliable detection of a flow of fuel vapour, such that it is possible to determine if a vapour flow is present or not.

[0012] These and other objects as well as advantages that will be apparent from the following description of the present invention are achieved by a vapour recovery system, a fuel dispensing unit and a method according to the respective independent claims. Preferred embodiments are defined in the dependent claims.

[0013] Hence a vapour recovery system is provided for recovering fuel vapour from a vehicle tank during dispensing of fuel into the vehicle tank. The vapour recovery system comprises a vapour recovery line with a vapour pump for transporting a stream of fuel vapour, and control means for controlling the stream of fuel vapour. The vapour line comprises a temperature sensor arranged for measuring a temperature of the fuel vapour, the control means being configured to determine how much a value representing the measured temperature deviates from a reference value, and to determine a flow of fuel vapour in dependence of said deviation.

[0014] The system according to the invention is advantageous in that it offers a convenient manner for detecting presence of a flow of fuel vapour. The detection is based on the principle that when a flow is present, the temperature deviation on the temperature sensor is higher in relation to when no flow is present. The temperature deviation is proportional to the flow of fuel vapour.

[0015] Furthermore, tests have shown that the temperature deviation is lower when vapour is recovered from a vehicle not equipped with ORVR (non-ORVR vehicle) in comparison with when vapour is recovered from a vehicle equipped with ORVR (ORVR vehicle), i.e. the temperature deviation is lower when vapour having a relatively high hydrocarbon content is recovered in comparison with when vapour having a relatively low hydrocarbon content is recovered. Preferably, the control means may not only determine, but also regulate the flow of fuel vapour in dependence of the deviation.

[0016] By using the technique described above, the system according to the invention may potentially provide secure detection of an ORVR vehicle.

[0017] The value representing the measured temperature may be the derivative of the measured temperature, the reference value being a reference temperature derivative.

[0018] Optionally, the value representing the measured temperature may be the measured temperature, while the reference value is a predetermined temperature value.

[0019] The temperature sensor may be arranged downstream the vapour pump, for applying the principle

that the temperature of a fluid is higher on the feeding side of a pump in comparison with the temperature of the fluid on the suction side of the pump, since the pressure is higher on the feeding side than on the suction side.

[0020] The vapour line may further comprise a second temperature sensor, wherein the reference value is a temperature measured by the second temperature sensor.

[0021] The second temperature sensor may be arranged in the vapour recovery line upstream the vapour pump, for measuring a temperature of the fuel vapour, which provides a very accurate reference temperature for determining the temperature deviation.

[0022] The control means may further be configured to determine said deviation by calculating how much the measured temperature exceeds the reference temperature, which offers a simple way for determining the temperature deviation.

[0023] The control means may further be configured to regulate the stream of fuel vapour only in dependence of how much the value representing the measured temperature deviates from the reference value. This means that the system is capable of detecting an ORVR vehicle based on information from one sensor only, or two sensors only in case the reference temperature is provided by a second temperature sensor. The reference temperature may be read from a predetermined pattern curve showing the temperature as a function of the flow of fuel vapour.

[0024] The control means may be configured to: make a first temperature measurement, by means of the temperature sensor; and make a second temperature measurement, by means of the temperature sensor and after a predetermined period of time has passed since the first temperature measurement; said determining of how much a value representing the measured temperature deviates from a reference value comprising determining a difference between the two temperature measurements, and comparing said difference with the reference value.

[0025] According to another aspect of the invention, a fuel dispensing unit for refuelling vehicles is provided, comprising a vapour recovery system according to above.

[0026] According to yet another aspect of the invention, a method is provided for regulating recovering of fuel vapour from a vehicle tank during dispensing of fuel into the vehicle tank, said method comprising the steps of: generating a stream of fuel vapour, through a vapour recovery line that comprises a vapour pump, measuring a temperature of the fuel vapour, determining how much a value representing the measured temperature deviates from a reference value, and determining a flow of fuel vapour in dependence of said deviation.

[0027] For example, the step of measuring a temperature of the fuel vapour downstream the vapour pump may be followed by the steps of: measuring a second temperature, and assigning the reference value the sec-

ond temperature. These two steps should be made before the step of determining how much the measured temperature deviates from the reference temperature.

[0028] The step of measuring the second temperature may comprise measuring the temperature of the fuel vapour upstream the vapour pump.

[0029] The fuel dispensing unit and method according to the invention both have the same advantages as the system according to the invention, and the method may comprise any of the features of the system described above.

Brief Description of the Drawings

[0030] Embodiments of the present invention will now be described, by way of example, with reference to the accompanying schematic drawing, in which

Fig. 1 is a schematic side view of a fuel dispensing unit.

Detailed Description of Preferred Embodiments of the Invention

[0031] With reference to Fig. 1, a fuel dispensing unit 1 is illustrated having a fuel line 12 with a fuel pump 13 drawing fuel from a fuel storage tank 17 and producing a stream of fuel F to a fuel dispensing nozzle 15 fitted with a fuel outlet 14. The volume and rate of dispensed fuel is measured by a flow meter 16 arranged in the fuel line 12.

[0032] In the fuel dispensing unit 1 a vapour recovery system 5 is provided, in which a vapour line 6 in downstream order comprises a vapour inlet 10 arranged at the fuel dispensing nozzle 15, a vapour pump 7 for generating a stream of vapour V to the storage tank 17, a temperature sensor 8 for detecting the temperature of the vapour stream V flowing in the vapour line 6 downstream the vapour pump 7 and a regulation valve 19 for regulating the vapour stream V. The regulation valve 19 may, instead of being arranged downstream the vapour pump 7, be arranged upstream the vapour pump 7.

[0033] During operation, the fuel outlet 14 and the vapour inlet 10 normally are positioned at the inlet of a vehicle fuel tank 18.

[0034] The fuel pump 13, the fuel meter 16, the vapour pump 7 and the regulation valve 19 are each connected to and controlled by control means 2. The temperature sensor 8 is also connected to the control means 2 and is arranged to feed, to the control means 2, a signal representing the temperature T of the vapour at the location of the temperature sensor 8.

[0035] The control means 2 has a suitable, conventional central processing unit 3 and associated memory 4 for processing and storing signals and for communicating with and controlling the devices connected to the control means 2. Such communication and control is performed in a conventional manner.

[0036] During operation, the fuel pump 13 feeds fuel to the vehicle tank 18. Simultaneously, the vapour pump 7 recovers, or draws, fuel vapour from the vehicle tank 18 at the same flow rate as the flow rate of the fuel. Accordingly, the volume of fuel that enters the tank 18 corresponds to the volume of vapour that exits the tank 18. This process is monitored and regulated by the control unit 2 in a known manner. The temperature T of the vapour is continuously measured by the temperature sensor 8 and the temperature value is sent to the control unit 2.

[0037] In a first embodiment, a reference temperature value is stored in the memory 4 of the control unit 2. The control unit 2 is configured to determine how much the temperature T deviates from the reference temperature, and if the deviation is higher than a predetermined value, the control unit 2 stops the vapour pump 7 and/or closes the regulation valve 19 for preventing that any vapour is recovered.

[0038] The reference temperature value is an experimental value, which for example is obtained by measuring temperature values with the sensor 8 when refuelling an ORVR vehicle and when refuelling a non-ORVR vehicle respectively, and by comparing the obtained temperature values. It has been shown that refuelling an ORVR vehicle results in higher temperature readings in comparison with refuelling a non-ORVR vehicle. The reference temperature value is then, for example, set to a value between a mean temperature value obtained for an ORVR vehicle and a mean temperature value obtained for a non-ORVR vehicle.

[0039] Hence, if the deviation is positive when subtracting the reference temperature from the measured temperature value, an ORVR vehicle is refueled. On the other hand, if the deviation is negative when subtracting the reference temperature from the measured temperature value, a non-ORVR is refueled. Accordingly, in the first embodiment the predetermined value mentioned above is zero. This presupposes that the fuel dispensing unit operates accurately, so that the temperature deviation actually depends on whether an ORVR vehicle is present or not, and not because of a problem with said fuel dispensing unit. Regulations can be made to assure that no problems with the fuel dispensing unit occur, thereby eliminating such problems as a cause of the deviation.

[0040] In a second embodiment, a second temperature sensor 9 is arranged in the vapour line 6 upstream the vapour pump 7 and is connected to the control means 2 for measuring the temperature T_{ref} of the vapour at the location of the second temperature sensor, and for feeding, to the control means 2, a signal representing the measured temperature T_{ref} . During operation, the temperature T_{ref} of the vapour is continuously measured by the second temperature sensor 9 and the temperature value is sent to the control unit 2.

[0041] The temperature T_{ref} measured by the second temperature sensor 9 represents the reference temper-

ature when determining how much the temperature T deviates from the reference temperature.

[0042] In the second embodiment the deviation is determined, for example, by subtracting the temperature T_{ref} measured by the second sensor 9 from the temperature T measured by the first sensor 8. The resulting deviation value is positive, and if the deviation is above a predetermined value, the control unit 2 stops the vapour pump 7 and/or closes the regulation valve 19 for preventing that any vapour is recovered.

[0043] The predetermined value in the second embodiment may be experimentally determined by measuring the deviation when refuelling an ORVR vehicle and when refuelling a non-ORVR vehicle. For example, if the tests show that refuelling an ORVR vehicle results in a deviation higher than 1 °C, while refuelling a non-ORVR vehicle results in a deviation lower than 1 °C, the predetermined level is set to 1 °C.

[0044] Of course, the stream of fuel vapour V is not stopped when experimentally determining the predetermined values discussed above.

[0045] Moreover, the deviation may be calculated in any suitable manner and the embodiments above represent only two examples.

[0046] Optionally, the predetermined values discussed above are dependant on the measured temperature T . This means that if the temperature T falls within a first temperature range, a first predetermined values is used, while a second predetermined value is used if the temperature falls within a second temperature range that is different from the first temperature range.

[0047] In a third embodiment, the temperature sensor that provides the reference temperature is arranged inside the fuel dispenser 1, but not in the vapour line 6, for measuring the temperature inside the fuel dispensing unit 1. In this embodiment the temperature sensor is indicated by the reference numeral 9' and the reference temperature by T'_{ref} . Apart from the location of the sensor, the third embodiment corresponds to the second embodiment. Of course, in the third embodiment the temperature sensor 9' may be arranged peripherally of the fuel dispensing unit 1.

[0048] In a fourth embodiment, the temperature sensor 8 is arranged downstream the vapour pump 7. The control means 2 measures in, cooperation with the temperature sensor 8, the vapour temperature a first time during the first 2-4 seconds of operation of the vapour recovery system. After a period of time, e.g. 10-15 seconds, a second temperature measurement is done. The control means 2 calculates a difference between the two measured temperature values, and if the difference is above a predetermined, empirically established value, it is determined that a flow of vapour is present.

[0049] This is based on the understanding that, if there is a flow of vapour, the vapour becomes warmer when passing a pump. If the pump is not operated, there is no vapour passing the pump and hence the temperature sensor senses the temperature of a static media, i.e.

there is no difference in temperature between the two measured temperature values. If the pump is operated there is a vapour flow, and the pump becomes warmer after a short period of time, which also makes the media slightly warmer after this period of time.

[0050] Of course, the temperature sensor need not be arranged downstream the pump, but may be arranged after any vapour line component that becomes warmer when a flow of vapour is passing through the vapour line.

Claims

1. A vapour recovery system for recovering fuel vapour from a vehicle tank (18) during dispensing of fuel into the vehicle tank (18), said vapour recovery system (5) comprising a vapour recovery line (6) with a vapour pump (7) for transporting a stream of fuel vapour (V), and control means (2) for controlling the stream of fuel vapour (V), **characterised in that** the vapour line (6) comprises a temperature sensor (8) arranged for measuring a temperature (T) of the fuel vapour, the control means (2) being configured to determine how much a value representing the measured temperature (T) deviates from a reference value (T_{ref}), and to determine a flow of fuel vapour in dependence of said deviation.
2. The vapour recovery system according to claim 1, wherein the the value representing the measured temperature (T) is the derivative of the measured temperature (T), the reference value being a reference temperature derivative.
3. The vapour recovery system according to claim 1, wherein the value representing the measured temperature (T) is the measured temperature, the reference value (T_{ref}) being a predetermined temperature value.
4. The vapour recovery system according to any one of claims 1-3, wherein the temperature sensor (8) is arranged downstream the vapour pump (7).
5. The vapour recovery system according to any one of claims 1-4, the vapour line (6) further comprising a second temperature sensor (9), wherein the reference value (T_{ref}) is a temperature measured by the second temperature sensor (9).
6. The vapour recovery system according to claim 5, wherein the second temperature sensor (9) is arranged in the vapour recovery line (6) upstream the vapour pump (7), for measuring a temperature of the fuel vapour.
7. The vapour recovery system according to any one of claims 1-6, wherein the control means (2) are fur-

ther configured to determine said deviation by calculating how much the measured temperature (T) exceeds the reference value (T_{ref}).

8. The vapour recovery system according to any one of claims 1-7, wherein the control means (2) are further configured to regulate the stream of fuel vapour (V) only in dependence of how much the value representing the measured temperature (T) deviates from the reference value (T_{ref}).
9. The vapour recovery system according to any one of claims 1-8, wherein the control means (2) is configured to:
 - make a first temperature measurement, by means of the temperature sensor (8), and
 - make a second temperature measurement, by means of the temperature sensor (8) and after a predetermined period of time has passed since the first temperature measurement,
 - said determining of how much a value representing the measured temperature deviates from a reference value comprising determining a difference between the two temperature measurements, and comparing said difference with the reference value.
10. A fuel dispensing unit for refuelling vehicles, comprising the vapour recovery system (5) of any one of claims 1-9.
11. A method of regulating recovering of fuel vapour from a vehicle tank (18) during dispensing of fuel into the vehicle tank (18), said method comprising the steps of:
 - generating a stream of fuel vapour (V), through a vapour recovery line (6) that comprises a vapour pump (7),
 - measuring a temperature (T) of the fuel vapour,
 - determining how much a value representing the measured temperature (T) deviates from a reference value (T_{ref}), and
 - determine a flow of fuel vapour in dependence of said deviation.
12. The method according to claim 11, wherein the step of measuring a temperature (T) of the fuel vapour downstream the vapour pump (7) is followed by the steps of:
 - measuring a second temperature, and
 - setting the reference value (T_{ref}) to the second temperature.
13. The method according to claim 12, wherein the step of measuring the second temperature comprises:

measuring a temperature of the fuel vapour, upstream the vapour pump (7).

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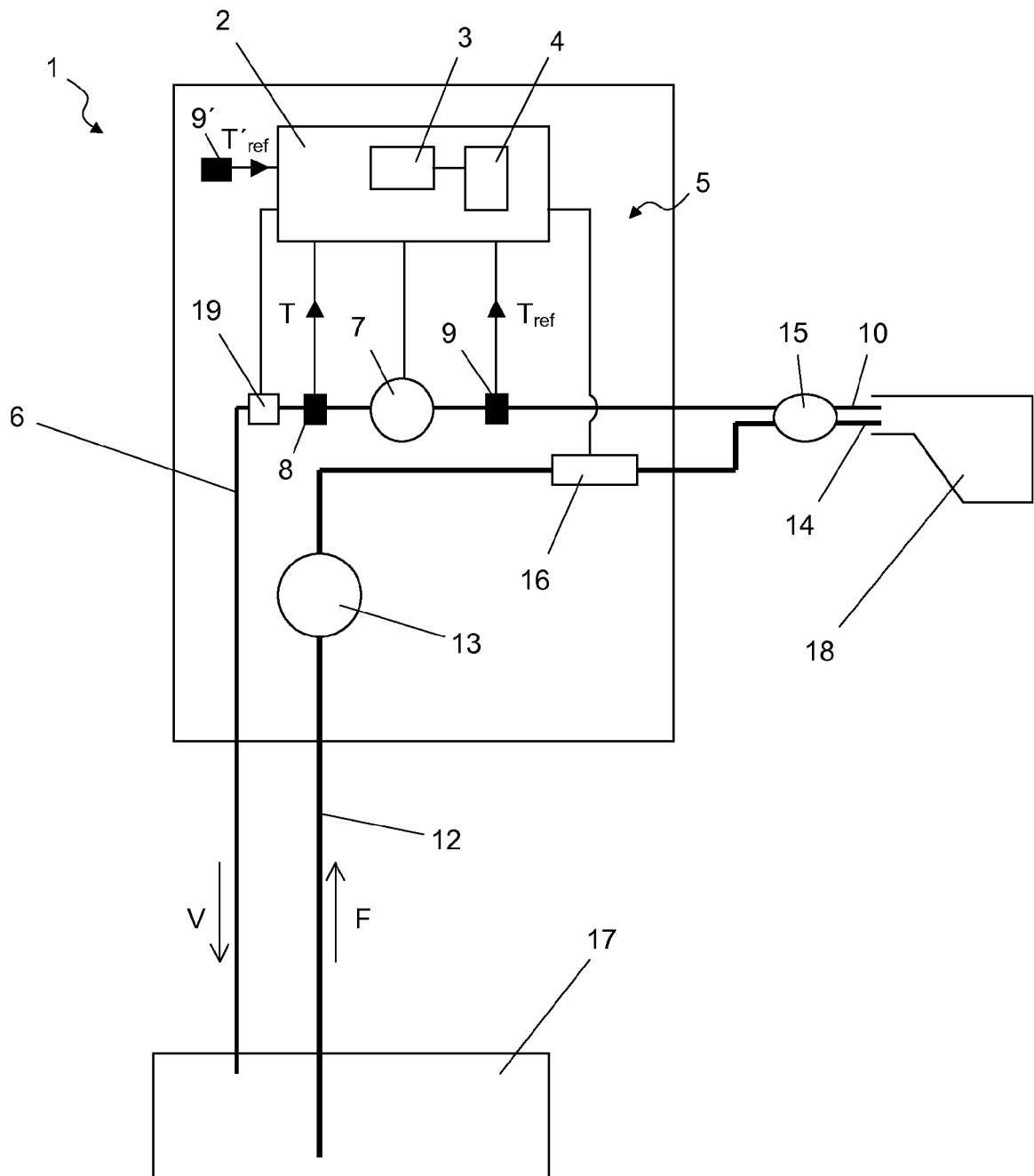


Fig. 1



EUROPEAN SEARCH REPORT

Application Number
EP 08 15 5803

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 1 905 731 A (DRESSER WAYNE AKTIEBOLAG [SE]) 2 April 2008 (2008-04-02) * paragraphs [0026], [0033], [0034]; figure 1 *	1-10	INV. B67D5/04
A	EP 1 568 653 A (FAFNIR GMBH [DE]) 31 August 2005 (2005-08-31) * paragraphs [0008] - [0010]; figure *	1	
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			TECHNICAL FIELDS SEARCHED (IPC)
			B67D
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 26 May 2009	Examiner Müller, Claus
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 08 15 5803

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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26-05-2009

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