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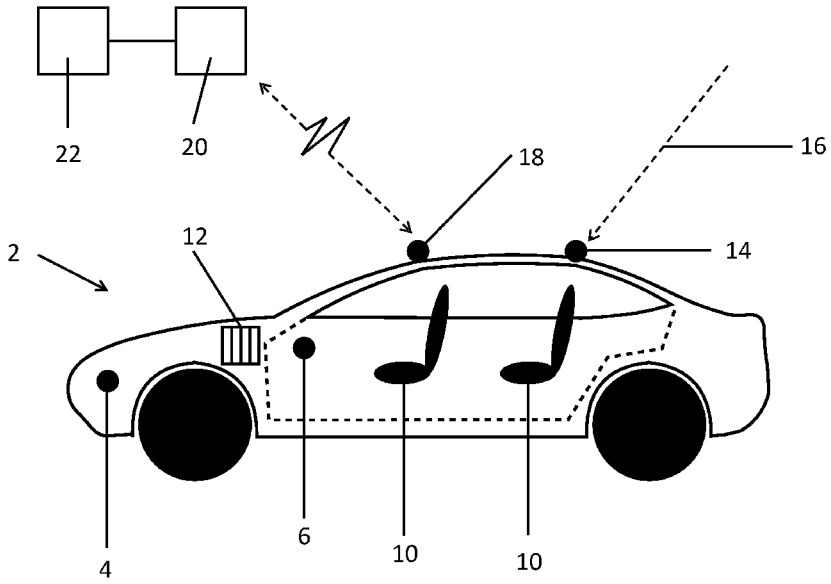


Fig. 1

(57) Abstract: A vehicle 2 comprises a receiver 18 for receiving data regarding air quality at the vehicle's current location. The vehicle also comprises an air inlet 12 which automatically controls ingress of air from the exterior of the vehicle to a vehicle cabin 8 depending at least partly on the received air quality data.

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Internal Air Quality in Vehicles

This invention relates to air quality in the context of vehicles, particularly the quality of air inside vehicles which is experienced by their occupants.

According to the World Health Organization, about 7 million people worldwide died prematurely as a result of air pollution in 2012, with 3.7 million of these deaths caused by outdoor air pollution. Traffic is a major source of air pollution, harming the environment as well as individuals. Vehicle manufacturers are committed to reducing the health risks from driving, and significant efforts have been made to solve the problem of reducing or preferably eliminating air pollution in vehicle interiors. Manufacturers worldwide have invested heavily in air quality solutions over the past few years, but none has yet been able to achieve a completely pollution-free interior space.

Whilst some cars currently available or planned have sensors for detecting air pollution, these tend to provide data about changes in outdoor air pollution, not the actual level of air pollution in the car cabin. Moreover the Applicant has identified a problem in the area of micro-sensor technology used in pollution sensors on vehicles – namely that whilst current sensors are reasonably good at detecting changes or variations in pollution, they are not able to provide an absolute value with a high enough accuracy.

The Applicant believes that there is significant scope for improvement in existing arrangements before they can provide real value.

When viewed from a first aspect the invention provides a vehicle comprising a receiver for receiving data regarding air quality at the vehicle's current location and an air inlet automatically controlling ingress of air from the exterior of the vehicle to a vehicle cabin depending at least partly on the received air quality data.

Thus it will be seen by those skilled in the art that in accordance with the invention the ingress of air to a vehicle is controlled automatically based on air quality data

received from elsewhere rather than relying just on any sensors on the vehicle itself. The Applicant has appreciated that this can give data that are reliable enough to control the air admitted into the vehicle and thus improve the internal environment for the driver and passengers by reducing or preventing the ingress of air when the vehicle is in an area of high pollution and providing or increasing the ingress of air when the external air is cleaner. The data could, for example, include data from a central server that is in communication with one or more high accuracy scientific air quality monitoring stations.

The received air quality data could be in the form of general map data – e.g. for a whole country or a region thereof which may be selectable by a user. This could then be used by the vehicle in conjunction with its location determined using e.g. Global Positioning System (GPS). In a set of embodiments therefore the vehicle is arranged to determine information regarding its current location. In a further set of embodiments the vehicle is arranged to transmit information regarding its current location. In a set of such embodiments the vehicle may receive air quality data which relates only to said location or a region containing said location.

The ingress of air could be determined completely by the received air quality data. However in a set of embodiments at least one other factor is taken into account. For example in a set of embodiments a user (vehicle occupant) can influence the ingress of air. Conveniently this could comprise a user being able to set the maximum amount of ingress (including fully prevented) when the vehicle is in a clean air area but the air ingress is still reduced or prevented when high pollution is determined. Equally it could allow a user to maintain air ingress when the air quality data would otherwise suggest that it should be prevented.

In a set of embodiments the ingress of air is also dependent on a number of people in the vehicle. This recognises that the more occupants there are, the greater will be the need for air to maintain an adequate oxygen level for respiration. Information regarding the number of occupants is generally readily available in modern cars e.g. as part of systems for ensuring that seatbelts are worn. Typically seat pressure sensors provide this information.

In a set of embodiments the ingress of air is dependent on an average speed of the vehicle. A low average speed might indicate that the vehicle is in heavy traffic and thus may be in a more polluted area for an extended period of time. This might indicate that air ingress would need to be provided despite the low air quality in order to maintain an adequate oxygen level for respiration. Similarly traffic data could be used to influence the air ingress.

In a set of embodiments the ingress of air is dependent on a history of the amount of air ingress. For example the air ingress could be provided or increased if it has been prevented for longer than a threshold period or if it is estimated that a total air circulation over a given period has been below a threshold.

In a set of embodiments the ingress of air is dependent on a route the vehicle is travelling. This could allow account to be taken of the vehicle entering a high pollution area before it does so – e.g. by increasing the air ingress before the vehicle arrives at the high pollution area when it will be prevented.

In a set of embodiments the vehicle comprises at least one sensor for measuring an air quality parameter inside the vehicle cabin and the air ingress is dependent on said measured internal air quality parameter. This could, for example, include oxygen or carbon dioxide level.

In a set of embodiments the air inlet comprises a valve arranged to control the air ingress in dependence upon the extent to which the valve is open or closed.

In a set of embodiments the air inlet comprises an arrangement for enhancing air flow. This could for example comprise a pump, fan, bellows or the like. Such an enhanced air flow arrangement could be provided in addition to, or instead of, a valve. Where it is provided in addition, it could be activated at a fixed speed whenever the valve is open. Alternatively the enhanced air flow arrangement may be controlled automatically such that its speed is determined by the required level of air ingress. In the latter situation the valve could simply be opened whenever the fan or the like is operational or closed when it is not. In other words air ingress could be controlled by the valve, by the enhanced air flow arrangement or by a combination of the two.

Where no valve is provided, references herein to air ingress being prevented should be understood to include an enhanced air flow arrangement not being operated, even though in practice some air may pass from the exterior if the vehicle to the interior.

In a set of embodiments the vehicle comprises an air treatment module which is controlled automatically such that the extent to which the air treatment module is employed depends at least partly on the received air quality data. The air treatment module could comprise a filter such as a dust filter, pollen filter or the like.

In a set of embodiments the vehicle is arranged to provide an indication of the received air quality and/or a status of the air inlet. This keeps the occupant(s) informed and could be useful in prompting the use to take other steps based on the received air quality data – e.g. closing windows. Indeed it is envisaged that the vehicle could be arranged to close any open windows automatically although car may be required to do so safely – e.g. by giving an audible warning first.

In a set of embodiments the vehicle comprises at least one sensor for measuring an external air quality parameter. This would allow the vehicle to make independent air quality measurements – e.g. to supplement or validate the received air quality data and/or to use if the external data is not available or cannot be received for any reason. In a set of such embodiments the vehicle comprises a transmitter for transmitting data from said sensor to an external server. This is beneficial in that it opens up the possibility of an external server gathering air quality data from a large number of vehicles which may not individually be able to provide very accurate data, but collectively allow an accurate statistical model to be built up. This model could further include data from one or more high accuracy scientific air quality monitoring stations. Advantageously this may be used to provide the air quality data referred to above, back to the individual vehicles in accordance with the invention.

Such an arrangement is novel and inventive in its own right and when viewed from a second aspect the invention provides a vehicle comprising: at least one sensor for measuring an air quality parameter; means for determining a location of the vehicle;

a transmitter for transmitting data from said sensor and information relating to said location to an external server, and a receiver for receiving data from an external source regarding air quality at the vehicle's current location, the vehicle being configured to use said data from the sensor and said received air quality data to determine an air quality in a vicinity of the vehicle.

In a set of embodiments of the second aspect of the invention the vehicle comprises an air inlet automatically controlling ingress of air from the exterior of the vehicle to a vehicle cabin depending at least partly on the received air quality data.

In a set of embodiments of either of the foregoing aspects of the invention the vehicle is arranged to calibrate its sensor using the received air quality data. This allows the vehicle to take more accurate measurements using the sensor – e.g. to enable the sensor to provide more accurate readings when suitable air quality data cannot be received by the receiver.

The sensor provided on the vehicle could be of any appropriate type. To give some non-limiting examples one of more the following sensors could be used: ozone sensors; particulate matter sensor (e.g. to sense PM2.5 and/or PM10 particulate matter); carbon monoxide sensors; carbon dioxide sensors; sulfur dioxide sensors; nitrous oxide sensors; nitric monoxide sensors; and nitrogen dioxide sensors.

As mentioned earlier, in some embodiments of the invention air quality data can be collected from vehicles and combined with data from one or more high accuracy scientific air quality monitoring stations. The data from the vehicles may be of lower accuracy but the potential to collect it from a large number of vehicles allows a large number of data points to be obtained. Moreover the data is obtained exactly where it is needed – along transport routes. By contrast scientific monitoring stations are necessarily limited in number and may be some distance away from most transport routes.

When viewed from a third aspect the invention provides a method of determining air quality at a plurality of locations comprising receiving first air quality data and location data from a plurality of vehicles, receiving second air quality data from one

or more fixed air monitoring stations and using said first and second air quality data to determine at least one air quality parameter at each of said plurality of locations.

Advantageously the method comprises providing said air quality parameter to one or more vehicles.

An embodiment of the invention will now be described, by way of example only, with reference to the accompanying drawings in which:

Fig. 1 is a schematic diagram showing a car in accordance with the invention;
Figs. 2a and 2b are schematic diagrams showing an air inlet being open and closed respectively;
Fig. 3 is a block diagram of a computer system on-board the car;
Fig. 4 is a representative portion of an air quality data map showing different air quality bands; and
Fig. 5 is a schematic system diagram of a wide area air quality monitoring system in accordance with another aspect of the invention.

Fig. 1 shows a car 2 which embodies the present invention. The car 2 comprises an external air quality sensor 4 which is mounted so that it may be subjected to the air in the immediate vicinity of the car. It may, for example, be placed in the engine bay as indicated schematically in Fig. 1. The car 2 also includes an internal air quality sensor 6 which is subject to the air which is inside the cabin 8 of the car occupied by the driver and any passengers. These sensors could comprise automotive air quality sensors from SGX Sensortech SA, Corcelles-Cormondreche, Switzerland.

The seats 10 provided in the car are equipped with pressure sensors (not shown) which are able to determine when a given seat is occupied.

An air inlet 12 allows air to pass between the exterior of the car 2 and the cabin 8 dependent upon the extent to which it is open or closed. This will be described in greater detail with reference to Figs. 2a and 2b. The car 2 also has a Global Positioning System (GPS) receiver 14 of a type well-known in the art for receiving GPS signals 16. There is also a further radio transmitter/receiver module 18 which

is able to communicate by means of radio communication with a corresponding receiver/transmitter 20 which is located remotely from the car 2. This communication could, for example, be by means of a cellular data network such as 4th generation long-term evolution (4G- LTE). The remote receiver/transmitter 20 is in data communication with a remote server 22.

Figs. 2a and 2b shows schematically automatic operation of the air inlet 12. The air inlet 12 includes a rotatable flap 24 which is moved by an electromechanical actuator 26 under the control of a microcontroller 28. Fig. 2a shows the inlet 12 in its open configuration in which air 30 is allowed to pass through the inlet from the exterior of the car to the cabin. However, upon the microcontroller 28 energising the actuator 26, the flap 24 is rotated by the actuator to the closed position as is illustrated in Fig. 2b thus preventing the passage of air 30 from the exterior of the car to the cabin. Although not shown, a fan may also be provided to enhance airflow. This could be placed in the immediate vicinity of the inlet 12 or at any convenient point upstream or downstream thereof.

The actuator 26 and flap 24 may have only fully open and fully closed positions as shown in in Figs. 2a and 2b respectively (in which case air ingress could be controlled by the speed of the fan if provided) , although more typically the actuator 26 is able to control the flap 24 to a number of different intermediate positions, or indeed any intermediate position by means of a suitable control signal from the microcontroller 28. The microcontroller 28 is therefore able to exercise control over whether and to what extent air can pass from the exterior of the car 2 to the cabin 8 via the inlet 12. Of course although only a single air inlet 12 is shown, two or more may be provided in the car 2 or any other vehicle to which the invention is applied.

Fig. 3 shows a basic system diagram for the parts of the air quality control system which are located on the car. At the heart of the system is a central computer 32 which could be a dedicated system or part of the vehicle's overall computer control system. The GPS receiver 14 and the cellular data transceiver 18 are both connected to the central computer 32 as is the microcontroller 28 for controlling the air inlet. It will be appreciated that the microcontroller 28 could be provided as part of the central computer 32 rather than being a separate module. Also connected to the computer is a user interface 34 which could take any convenient form such as a

touchscreen, voice activation detector, gesture activation detector etc. and again could be a dedicated user interface for the air quality control system or could be part of the main user interface provided for the vehicle. Exemplary operation of the embodiment will now be described with further reference to Fig. 4.

In a basic form of operation, the car 2 receives air quality data over the air from the remote server 22 via the radio frequency data link 18, 20. This could be in the form of map data as is illustrated in Fig. 4. Here it may be seen that a map 36 has overlaid on it bands 38a, 38b and 38c. The area 38a indicates a zone of low pollution in which it is safe for vehicles to admit ambient air. The second zone 38b is one in which there is moderate air pollution which signifies that the amount of air which vehicles admit to their interior should be reduced. The final zone 38c indicates an area of high air pollution where air should ideally not be admitted into the interiors of vehicles, subject to other considerations as will be explained later.

The air quality map data is stored and processed by the central computer 32 in the car. The central computer 32 takes account of the vehicle's actual location as provided by the GPS receiver 14 and this could be overlaid onto the map 36 as indicated by the plotted line A-B in Fig. 4. The car's route could be built up in real time or could be generated by an on-board navigation system also using the GPS data 16.

If the computer 32 determines that the car 2 is in a low pollution zone 38a, it may issue a signal to the microcontroller 28 to open the flap 24 of the air inlet by operating the actuator 26. However, once the car 2 enters the moderate pollution zone 38b, this is detected by the computer 32 which then issues an instruction to the microcontroller 28 to close the flap 24 partially so that the amount of air that can come into the cabin 8 is reduced. Similarly, if the car 2 enters the high pollution zone 38c, the computer 32 issues a signal to the microcontroller 28 to close the flap 24 of the air inlet as shown in Fig. 2. This prevents the pollution from entering the cabin 8 of the car. An indication may be given – e.g. by means of the user interface 34 - to alert a user to the fact that the car has entered a particular zone and therefore that the air inlet will be opened or closed accordingly. As well as generally informing the occupant(s) this could act as a prompt to close or open

windows. In another set of embodiments the windows are opened or closed automatically along with the air inlet 12.

Although not illustrated in the Figures, the received air quality data could be used to decide whether or to what extent to operate a filter such as a dust filter or pollen filter. This could be based on the same part of the data as is used to influence the air inlet or a separate part of the data could be used – e.g. the received air quality data could include a pollen count in addition to other metrics.

Although the computer 32 is able to control the position of the flap 24 depending upon the air quality data received from the remote server, other factors may influence the extent at which the inlet is opened. In particular, the user interface 34 can be used by an occupant of the car to alter or override the setting dictated by the computer 32. This would allow the occupant to open the air inlet even in an area of high pollution if that is what he or she wished to do.

Other factors may also be taken into account in deciding to what extent the air inlet 12 is open. For example the internal air quality sensor 6 may be used to measure the level of oxygen of carbon dioxide in the cabin 8 so that the computer 32 can order the air inlet 12 to be opened if the level of oxygen becomes too low or the level of carbon dioxide becomes too high.

The computer 32 also receives inputs from the pressure sensors in the seats 10 which allows it to determine the number of occupants in the car. This can be used to influence how much air is admitted into the cabin 8. For example, if the car 2 is full, the computer 32 can decide to keep the air inlet 12 open for longer or opened more fully, even if the car enters or is in a higher pollution zone, in order to ensure that there is sufficient air flow for the comfort of the occupants. On the other hand, if there is only a driver, it may be feasible to close the air inlet 12 more fully in moderate or high pollution areas. The seat sensors could be used as part of algorithm operated by the computer 32 which takes account of the relative lengths of time for which the air inlet has been open or closed over a given period and uses these to determine whether the inlet may be closed or should be kept open. Although somewhat indirect, this may give sufficient accuracy to obviate the need for monitoring air quality inside the cabin. More generally the time for which the

inlet has been open or closed could be used to influence whether or to what extent it is opened at any given moment.

As mentioned above, where the car is following a predetermined route, established for example by a GPS based navigation system, the computer 32 could use this to affect the status of the air inlet 12. There are many ways in which this could be used and the precise operation will typically be determined by individual designers, but one possibility would be to keep the inlet closed for a little longer, even if it has been closed for a threshold period of time already, if the car is about to move into a low pollution zone. Another option would be to close the inlet fully when entering a moderate pollution zone if the car will shortly leave it, but to leave the air inlet open partially if the car is expected to remain in it for a long time.

In some applications of the invention, the external air quality sensor 4 may not be required in view of the air quality data received from the remote server 22. However in other applications it may still be beneficial to have it, despite the fact that typically such sensors are relatively inaccurate when providing absolute readings as opposed to detecting changes. The external sensor 4 could, for example, be used to provide input to the computer 32 on air quality when the car cannot receive the wireless data – e.g. because it is out of network coverage. It could also be used to supplement the information received wirelessly from the server 22. However the wireless data can also be used to calibrate the sensor 4 to enhance its accuracy. This would make it possible, in an alternative embodiment, to use the external air quality sensor 4 to determine or partly determine the extent to which the air inlet 12 is open with the wirelessly received air quality data being used only to calibrate the sensor 4.

As well as being a user of externally provided air quality data, the car 2 could also contribute to it as will be explained with further reference to Fig. 5. When operating in this way the car 2 transmits data from its external air quality sensor 4 to the remote server 22 along with its current location as determined using the GPS signal 16. This then allows the remote server 22 to update its air quality model with the actually measured data (or pass on the data to another computer to do so). Although this may not be as accurate as might be desirable, if data from many

vehicles in a similar location is received, a more accurate statistical picture may be built up.

Fig. 5 shows schematically a wide area air quality monitoring system. A central mainframe computer 40 runs a statistical model of air quality over a geographic region. It receives high accuracy data from fixed scientific air quality monitoring stations 42. It may also receive feeds of weather data, traffic data, historical data etc.

In addition however the computer 40 receives air quality sensor data and location data from vehicles 2, 44, 46, 50 by means of wireless data communication indicated schematically by the antennae 46. In practice these would be distributed geographically to ensure adequate coverage and would conveniently be provided by an existing cellular data network as previously described. One of these could correspond to the transceiver 20 depicted in Fig. 1. Similarly it will be appreciated that the car 2 described with reference to the earlier Figures could be one of the vehicles which interacts with the system of Fig. 5. Other vehicles 44, 46 may be of different type – e.g. trucks, vans, buses etc. but each has the capability to receive air quality data - e.g. to control an air inlet thereof or for another purpose - and to transmit its own measured data with location as mentioned above.

However the system can also accommodate vehicles 50 which provide air quality sensor data but do not have the capability - or choose not - to receive air quality data. Similarly it can also accommodate vehicles 52 which use the received air quality data - e.g. to control an air inlet thereof or for another purpose – but do not or cannot provide air quality sensor data.

As will be appreciated this arrangement has the potential to provide a powerful model of air quality, particularly if a large number of vehicles 2, 44, 46, 50 provide air quality sensor data. Determining the particular modelling technique and algorithms used by the computer 40 is within the capability of those skilled in the art and is not essential to this aspect of the invention. What is believed to be valuable here is the provision of data into the model from a (preferably large) number of vehicles to be combined with the 'scientific' data from fixed stations and, preferably,

the provision of the corresponding output of the model back to at least some of those vehicles (amongst others).

It will be appreciated by those skilled in the art that the embodiments described above are merely exemplary and are not limiting on the scope of the invention. For example although three different pollution levels were described (high, intermediate and low), any number of levels or a continuous numerical parameter could be used.

Although air quality has been illustrated using the example of pollution (which could take many forms such as particular gases, mixes of gas or particulates), this is not limiting and other indicators of air quality could be employed such as ozone concentrations, carbon dioxide level etc.

Other factors that those mentioned could be used as well as or instead of them, in any combination, to control the air inlet. Example of this would be the vehicle's speed, traffic data, pre-programmed preferences etc.

Claims

1. A vehicle comprising a receiver for receiving data regarding air quality at the vehicle's current location and an air inlet automatically controlling ingress of air from the exterior of the vehicle to a vehicle cabin depending at least partly on the received air quality data.

2. The vehicle as claimed in claim 1, further arranged to determine information regarding its current location.

3. The vehicle as claimed in claim 2, further arranged to transmit information regarding its current location.

4. The vehicle as claimed in claim 3, wherein the vehicle is arranged to receive air quality data which relates only to said location or a region containing said location.

5. The vehicle as claimed in any preceding claim, wherein a user can influence the ingress of air.

6. The vehicle as claimed in any preceding claim, wherein the ingress of air is also dependent on a number of people in the vehicle.

7. The vehicle as claimed in any preceding claim, wherein the ingress of air is dependent on an average speed of the vehicle.

8. The vehicle as claimed in any preceding claim, wherein the ingress of air is dependent on a history of the amount of air ingress.

9. The vehicle as claimed in any preceding claim, wherein the ingress of air is dependent on a route the vehicle is travelling.

10. The vehicle as claimed in any preceding claim, further comprising at least one sensor for measuring an air quality parameter inside the vehicle cabin and the air ingress is dependent on said measured internal air quality parameter.

11. The vehicle as claimed in any preceding claim, wherein the air inlet comprises a valve arranged to control the air ingress in dependence upon the extent to which the valve is open or closed.

12. The vehicle as claimed in any preceding claim, wherein the air inlet comprises an arrangement for enhancing air flow.

13. The vehicle as claimed in claim 12, wherein the air inlet comprises a valve and the enhanced air flow arrangement is activated at a fixed speed whenever the valve is open.

14. The vehicle as claimed in claim 12, wherein the enhanced air flow arrangement is controlled automatically such that its speed is determined by the required level of air ingress.

15. The vehicle as claimed in any preceding claim, further comprising an air treatment module which is controlled automatically such that the extent to which the air treatment module is employed depends at least partly on the received air quality data.

16. The vehicle as claimed in any preceding claim, wherein the vehicle is arranged to provide an indication of the received air quality and/or a status of the air inlet.

17. The vehicle as claimed in any preceding claim, further comprising at least one sensor for measuring an external air quality parameter.

18. The vehicle as claimed in claim 17, further comprising a transmitter for transmitting data from said sensor to an external server.

19. The vehicle as claimed in claim 17 or 18, arranged to calibrate said sensor using the received air quality data.

20. A vehicle comprising: at least one sensor for measuring an air quality parameter; means for determining a location of the vehicle; a transmitter for transmitting data from said sensor and information relating to said location to an external server, and a receiver for receiving data from an external source regarding air quality at the vehicle's current location, the vehicle being configured to use said data from the sensor and said received air quality data to determine an air quality in a vicinity of the vehicle.

21. The vehicle as claimed in claim 20, further comprising an air inlet automatically controlling ingress of air from the exterior of the vehicle to a vehicle cabin depending at least partly on the received air quality data.

22. The vehicle as claimed in claim 20 or 21, arranged to calibrate said sensor using the received air quality data.

23. A method of determining air quality at a plurality of locations comprising receiving first air quality data and location data from a plurality of vehicles, receiving second air quality data from one or more fixed air monitoring stations and using said first and second air quality data to determine at least one air quality parameter at each of said plurality of locations.

24. The method as claimed in claim 23, further comprising providing said air quality parameter to one or more vehicles.

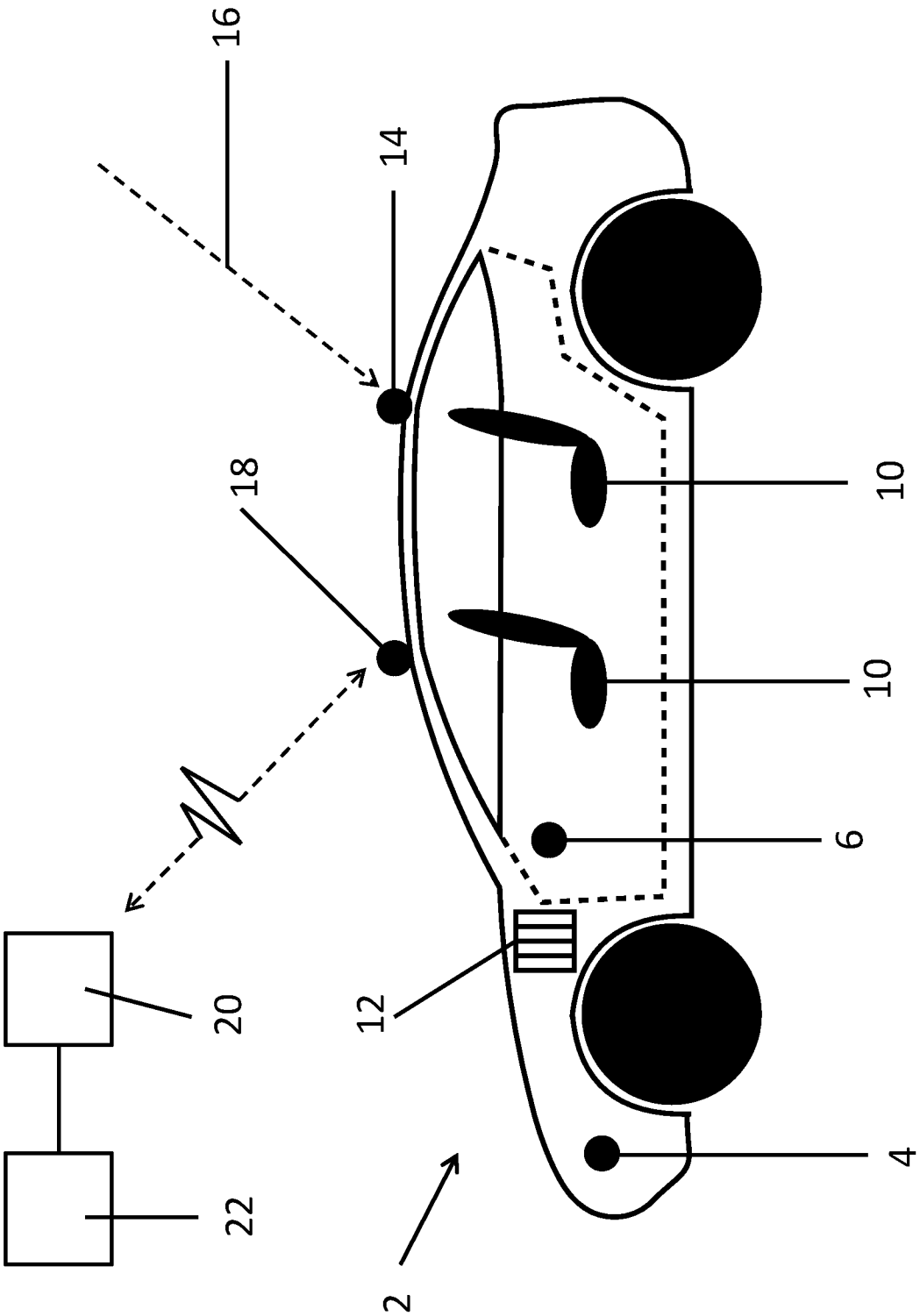


Fig. 1

Fig. 2a

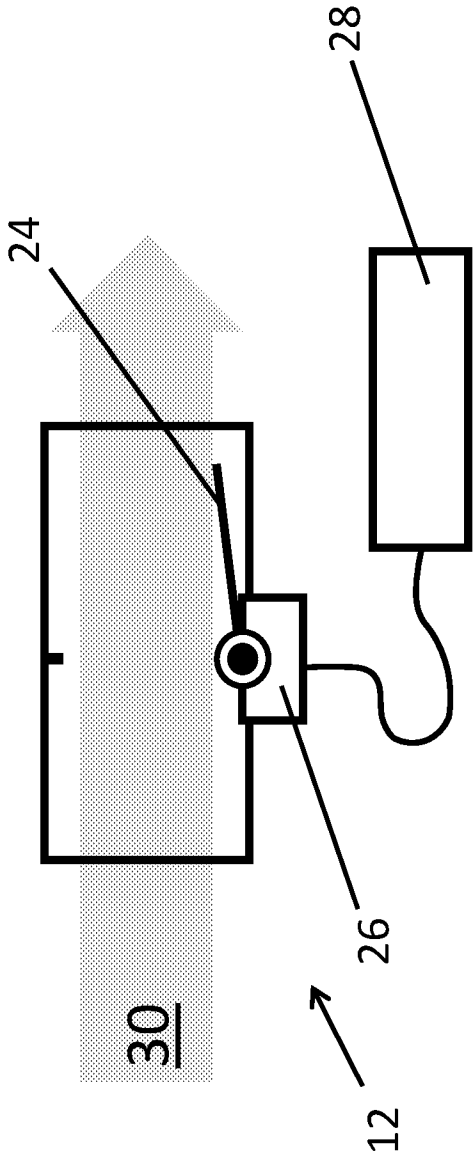
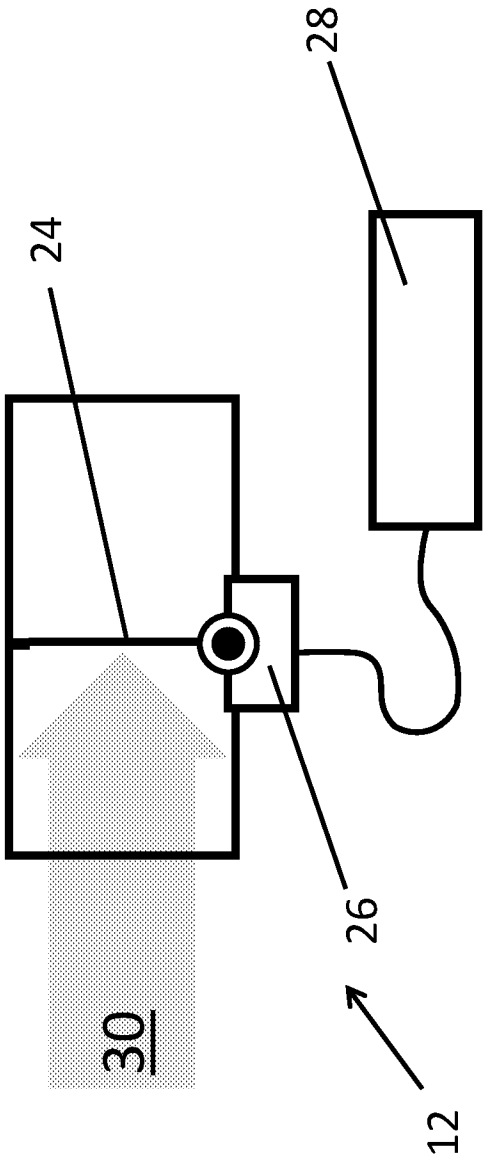


Fig. 2b



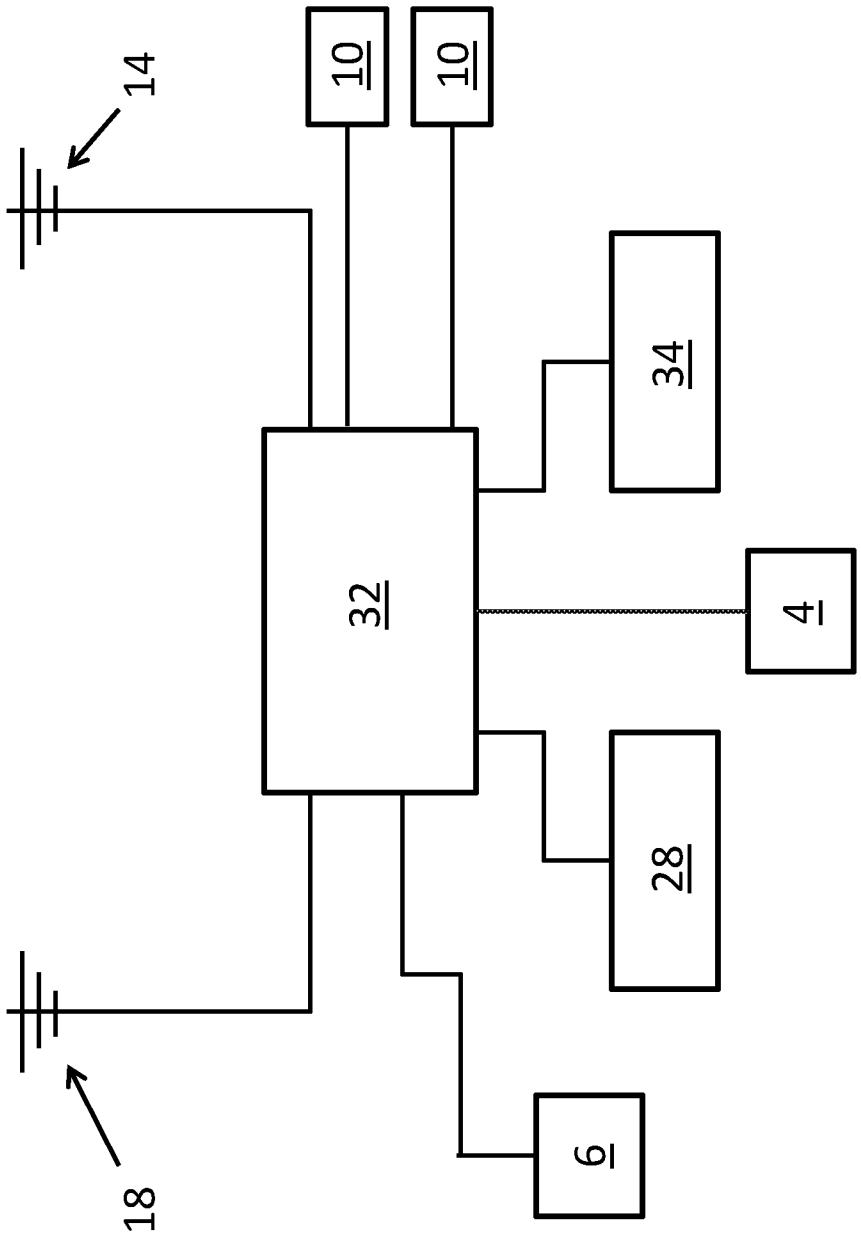


Fig. 3

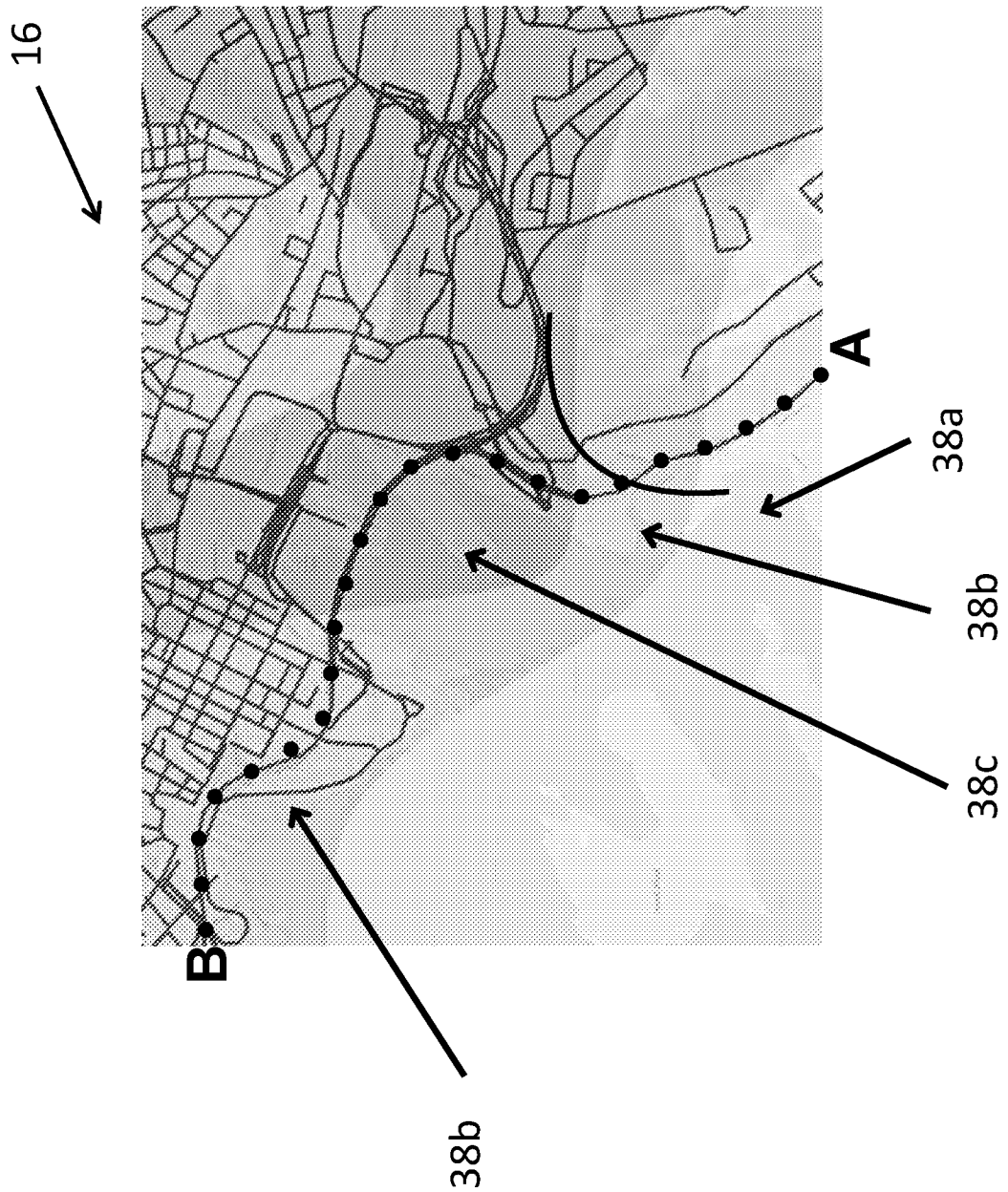


Fig. 4

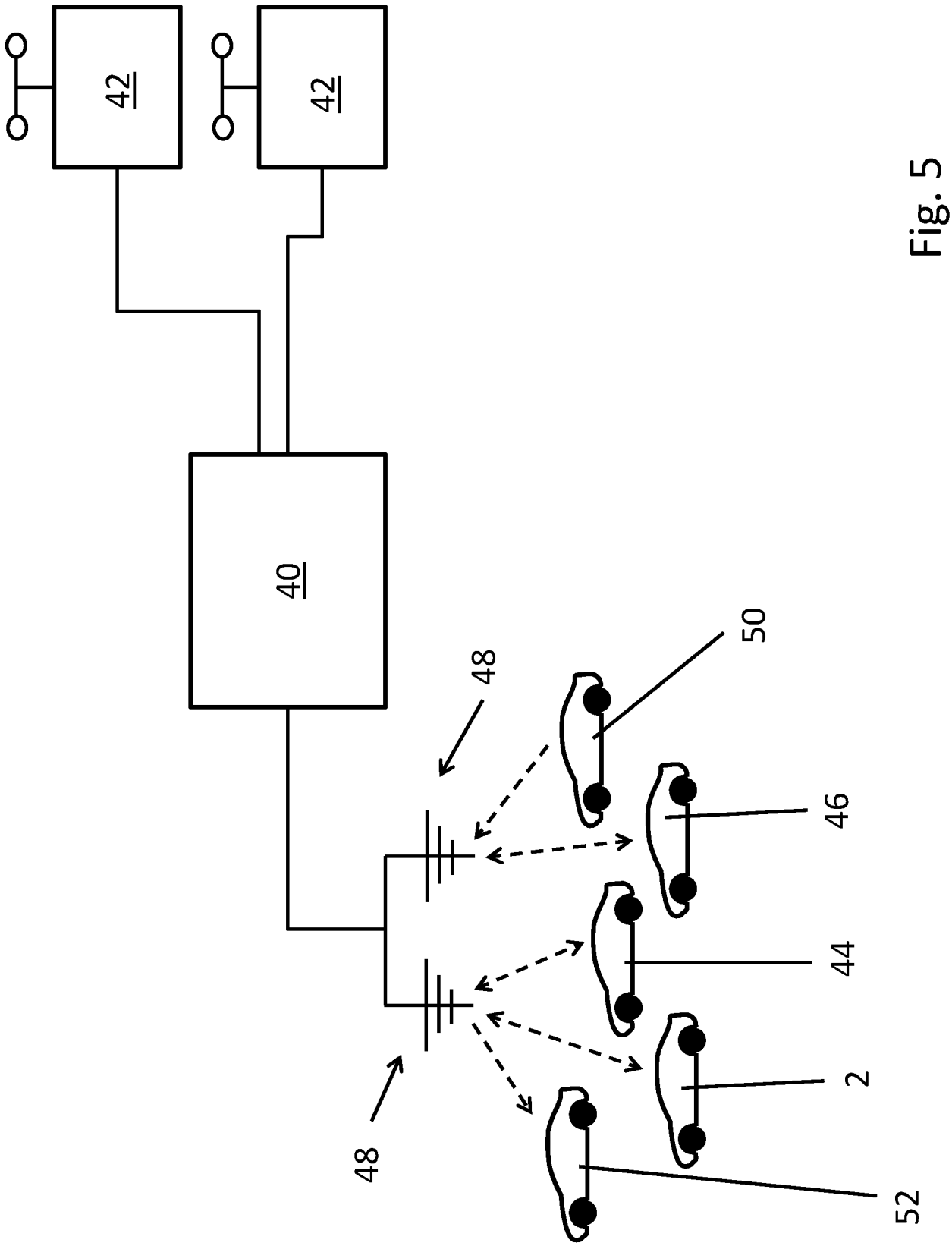


Fig. 5

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2017/050522

A. CLASSIFICATION OF SUBJECT MATTER
INV. B60H1/00 G08G1/0967
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)
B60H G08G

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

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2007/064269 A1 (VOLVO LASTVAGNAR AB [SE]; HAGBERG YNGVE [SE]) 7 June 2007 (2007-06-07) page 15, line 15 - page 23, line 17; figures 1-3	1-24
X	US 2009/326760 A1 (CLARK JASON W [US] ET AL) 31 December 2009 (2009-12-31) paragraphs [0023] - [0026]; figures 1-4	1-24
X	DE 10 2009 046828 A1 (BOSCH GMBH ROBERT [DE]) 19 May 2011 (2011-05-19) the whole document	1-9, 17-24
X	WO 2010/075874 A1 (TOMTOM INT BV [NL]; TERTOOLEN SIMONE [NL]) 8 July 2010 (2010-07-08) pages 14,15; figures 7,8	1-19

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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

"E" earlier application or patent but published on or after the international filing date

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
16 May 2017	24/05/2017

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Gumbel, Andreas

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2017/050522

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 10 2013 220595 A1 (BOSCH GMBH ROBERT [DE]) 16 April 2015 (2015-04-16) paragraphs [0077] - [0084]; figures 1,2 -----	1-19

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/GB2017/050522

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2007064269 A1	07-06-2007	EP 1957300 A1	20-08-2008
		WO 2007064269 A1	07-06-2007
US 2009326760 A1	31-12-2009	NONE	
DE 102009046828 A1	19-05-2011	NONE	
WO 2010075874 A1	08-07-2010	NONE	
DE 102013220595 A1	16-04-2015	CN 105593040 A	18-05-2016
		DE 102013220595 A1	16-04-2015
		WO 2015051959 A1	16-04-2015