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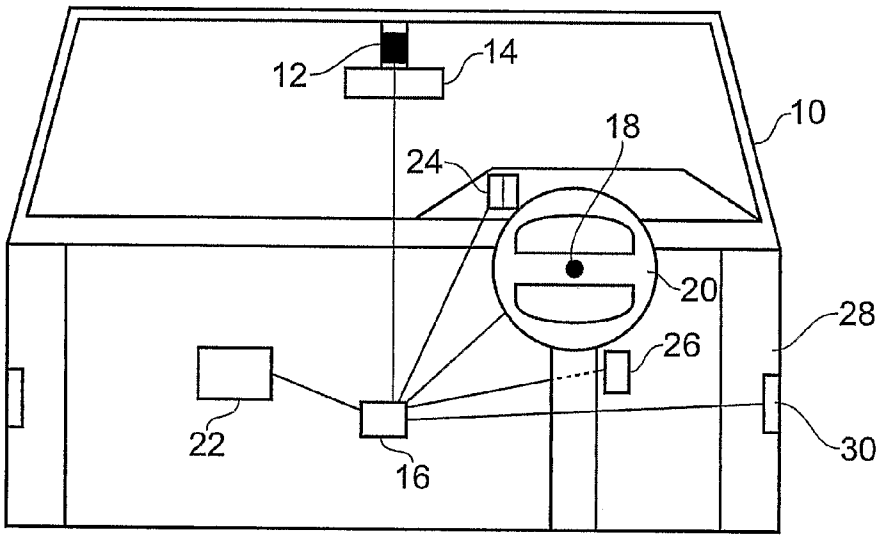

(57) Abstract: A system for inhibiting operation of a vehicle (10) by a person who has consumed alcohol comprises an alcohol testing device (18) for measuring the level of alcohol in a breath sample provided by a person intending to operate the vehicle, whereby the vehicle is disabled if the measured level of alcohol is found to exceed a specified limit, and an infrared imaging device (12) operable to image a region including the operator' s seat and determine the presence or absence of a person in the seat. The vehicle can be disabled if the infrared imaging device detects that the person leaves the seat after providing a satisfactory breath sample for enabling the vehicle, or that a second person is present near the alcohol testing device. A door sensor may also be included to allow disablement of the vehicle if the door is opening after the vehicle is enabled in response to a satisfactory alcohol test.

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TITLE OF THE INVENTION

ALCOHOL TEST-BASED SYSTEM AND METHOD FOR VEHICLE CONTROL

BACKGROUND OF THE INVENTION

The present invention relates to a vehicle safety system and a vehicle control method based on testing an occupant of the vehicle for alcohol.

It is widely recognised that operating vehicles and other machinery while under the influence of alcohol can be dangerous, and many countries have legislation setting a limit on the alcohol in a driver's breath or blood above which driving a vehicle is illegal.

A number of systems have been proposed for incorporation into a vehicle which take a sample of breath from a driver, test the sample for alcohol, and immobilise the vehicle if the sample is found to contain a level of alcohol above a certain limit, such as the limit set by local law. The alcohol testing tends to fall into two main categories: requiring the driver to blow into a tube to provide a breath sample to a testing chamber (as described in GB 2,361,343); or obtaining a sample by using a fan to extract air from the vehicle interior in the vicinity of the driver (as described in GB 1,401,318). The testing apparatus is in communication with a suitable engine immobilising device that operates to prevent the vehicle engine being started if the alcohol level in the breath sample is found to be too high.

A problem with a basic stand-alone alcohol testing apparatus is that it can be possible for a person other than the driver to provide the breath sample and activate the vehicle, then allowing the driver, who may be over the alcohol limit for driving, to drive the car. GB 2,232,284 seeks to address this by providing an alcohol test system for a vehicle that includes sensors in the vehicle door and in the driver's seat. The seat sensor detects the weight of a person in the driver's seat and activates an alcohol

breath tester. If the test is passed, the vehicle is made operational. If the door then opens and the person in the driver's seat moves, the sensors detect this activity and the vehicle is rendered non-operational again. Thus, the person who took the test and started the vehicle is prevented from changing places with a second person who may be over the alcohol limit. However, there is nothing to stop a sober person from taking the test on behalf of a drunk person already occupying in the driver's seat by leaning over from the passenger seat or leaning through the driver's door window, for example. Thus, the system can be abused.

Techniques for determining vehicle seat occupancy are also of wider interest. EP 1,469,414 describes an active infrared imaging system that records video images of vehicle occupants and uses the results to improve airbag deployment. The images are obtained by directing infrared radiation from a local source onto a vehicle seat and analysing the reflected light to determine seat occupancy. The seats are coated with a reflective substance to provide enhanced infrared reflectivity as compared to the reflectivity of an occupant of the seat, so that the occupant can be readily distinguished from the seat. US 6,793,242 describes many vehicle occupancy sensing systems that provide information about occupant location and position used to control functions including airbag deployment, entertainment system operation, and communication with a remote location in the event of an accident (including measuring the amount of alcohol exhaled by the driver and notifying this information to the remote location). Some of the systems are active radiation-based systems that direct radiation such as ultrasound onto a seat and process the reflected radiation to determine information about an occupant of the seat. One passive system measures infrared radiation from occupants to obtain information about occupant body temperature that is used to control the vehicle's heating and air-conditioning systems.

SUMMARY OF THE INVENTION

A first aspect of the present invention is directed to an alcohol test-based vehicle safety system comprising: an alcohol sensing device operable to measure the level of alcohol in a sample of breath provided by an occupant of a driver's seat in a vehicle, the system being operable to disable the vehicle in the event of a level of alcohol measured by the alcohol sensing device exceeding a specified threshold; and an infrared imaging device operable to image an occupancy region of the driver's seat to determine the presence or absence of an occupant in the occupancy region, the occupancy region including an input of the alcohol sensing device, the system being further operable to disable the vehicle in the event that the infrared imaging device determines that an occupant in the occupancy region who has provided a sample of breath leaves the occupancy region.

Use of an infrared imaging device or system in conjunction with an alcohol sensing and testing device is considered to provide a robust arrangement for not allowing operation of a vehicle if circumstances suggest that there has been an attempt to circumvent an alcohol test required to enable operation of the vehicle. Imaging an occupancy region of the driver's seat allows an occupant leaving the seat to be detected, and since this may point to an exchange of occupants or other manoeuvre intended to outwit the testing device, the vehicle can be disabled. Enablement of the vehicle can be achieved by an occupant of the driver's seat providing a sample of breath and then remaining in the seat; the infrared imaging device can determine that this has happened. Infrared imaging allows imaging to be carried out day or night regardless of light levels and avoids problems with optical image processing whereby it may be difficult to distinguish an occupant from the seat or other surroundings.

The system may be further operable to disable the vehicle in the event that the infrared imaging system determines the presence of more than one occupant in the occupancy region. This addresses the circumstances in which a driver may attempt to cheat the alcohol test by having a second person provide the sample of breath, since

this would require the second person to enter the occupancy region, and hence be detected by the infrared imaging system.

The system may further comprise a door sensor device operable to detect opening and closing of a door of the vehicle that gives access to the driver's seat, the system being further operable to disable the vehicle in the event that the door sensor device detects opening of the door after the infrared imaging device has determined the presence of an occupant in the occupancy region. This further hinders attempts to abuse the alcohol test, particularly by an occupant who has enabled the vehicle, whether or not detected by the infrared imaging system, subsequently leaving the vehicle. Also, the door sensor device may be further operable to activate the vehicle safety system in the event that opening and subsequent closing of the door is detected. This provides a convenient automated way of initiating the alcohol test when an occupant enters the vehicle.

The system may be further operable to activate the alcohol sensing device to make an alcohol level measurement if the infrared imaging device determines the presence of an occupant in the occupancy region. The various components of the system can thereby be activated only if required, which saves power.

The system may further comprise a display device visible to an occupant in the occupancy region operable to display a signal prompting the occupant to provide a sample of breath to the alcohol sensing device when the alcohol sensing device is activated. A display device makes the system more "user-friendly", and aids the occupant by reminding him that it is necessary to take an alcohol test before the vehicle can be used.

The system may further comprise a vehicle immobilising device reversibly activatable by the system to disable the vehicle. Although any arrangement or configuration able to control whether the vehicle can or cannot be operated may be used to enable or disable the vehicle, a dedicated vehicle immobilising device can be

provided. This may make the system more suitable for retro-fitting to an existing vehicle, for example, or make maintenance and parts replacement more convenient.

The system may further comprise a central control unit to which at least some of the devices comprised in the system are connected and which is operable to control and co-ordinate operation of those devices to disable the vehicle. A central unit may give the option of more complex functionality of the system, offering a convenient way to implement a wider range of features to improve safety, efficiency, user interaction and the like. It may also be simpler than direct connection between various components, particularly for a system comprising a large number of separate devices.

The infrared imaging device may comprise a passive infrared thermal imaging device, such as an infrared microbolometer array. Alternatively the infrared imaging device may comprise an illuminated infrared imaging device.

The infrared imaging device may be operable to determine the presence or absence of an occupant in the occupancy region by obtaining one or more infrared images of the occupancy region and processing the one or more infrared images to identify any image features indicative of the presence of an occupant. For example, processing the one or more infrared images may comprise the use of pattern recognition techniques, or comparing the one or more infrared images with a library of infrared images of occupants in the occupancy area.

The alcohol sensing device may comprise a tube into which an occupant of the occupancy region can blow to provide a sample of breath, a chamber for receiving the sample of breath via the tube, and one or more alcohol sensors located in the chamber to measure the level of alcohol in the sample of breath. A device of this kind is useful in that the air sample intake is localised and requires contact from the occupant giving the breath sample, making it straightforward to determine by infrared imaging that a sole occupant of the driver's seat is the person who gives the sample.

A second aspect of the present invention is directed to a vehicle fitted with a vehicle safety device according to the first aspect of the invention.

A third aspect of the present invention is directed to a method of controlling a vehicle using an alcohol test, comprising: imaging an occupancy region of a driver's seat in the vehicle to determine the presence or absence of an occupant in the occupancy region using an infrared imaging device, the occupancy region including an input of an alcohol sensing device; using the alcohol sensing device to obtain a sample of breath from an occupant determined to be present in the occupancy region; measuring a level of alcohol in the sample of breath; disabling the vehicle in the event that the measured level of alcohol exceeds a specified threshold; and disabling the vehicle in the event that the occupant, having provided the sample of breath, is determined to have left the occupancy region.

The method may further comprise disabling the vehicle in the event that more than one occupant is determined to be present in the occupancy region. The method may further comprise monitoring opening and closing of a door of the vehicle that gives access to the driver's seat, and disabling the vehicle in the event that the door is opened after the presence of an occupant in the occupancy region has been determined. The method may further comprise commencing imaging the occupancy region in the event that the door is opened and subsequently closed.

The level of alcohol may be measured using an alcohol sensing device which is activated to make an alcohol level measurement if an occupant is determined to be present in the occupancy region. The method may further comprise displaying to the occupant a signal prompting the occupant to provide a sample of breath when the alcohol sensing device is activated.

The occupancy region may be imaged using a passive infrared thermal imaging device, such as an infrared microbolometer array. Alternatively the occupancy region may be imaged using an illuminated infrared imaging device. Determining the presence or absence of an occupant in the occupancy region may comprise processing one or more infrared images of the occupancy region to identify any image features indicative of the presence of an occupant. Processing the one or more infrared images

may comprise the use of pattern recognition techniques, or comparing the one or more infrared images with a library of infrared images of occupants in the occupancy area.

Measuring a level of alcohol in the sample of breath may comprise using an alcohol sensing device comprising a tube into which an occupant determined to be in the occupancy region can blow to provide the sample of breath, a chamber for receiving the sample of breath via the tube, and one or more alcohol sensors located in the chamber to measure the level of alcohol in the sample of breath.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the invention and to show how the same may be carried into effect reference is now made by way of example to the accompanying drawings in which:

Figure 1 shows a schematic representation of a vehicle testing system in accordance with an embodiment of the invention;

Figure 2 shows a schematic representation of an example central control unit that can be used in the system of Figure 1; and

Figure 3 shows a flow chart illustrating steps in a method of controlling a vehicle in accordance with an embodiment of the present invention.

DETAILED DESCRIPTION

A vehicle safety system according to embodiments of the present invention utilises apparatus for measuring the amount of alcohol in a driver's breath after the driver enters the vehicle and subsequently enabling or disabling driving of the vehicle together with an occupancy-determining apparatus based on infrared imaging that disables the vehicle in the event that the alcohol test is found to be being avoided or otherwise cheated by the driver.

Previously proposed systems that seek to eliminate exchange of driver's seat occupant after a vehicle is activated in response to an allowable alcohol test, such as that described in GB 2,232,284, can often be readily abused in that a second person can take the test while the driver, who may be intoxicated, remains in the driver's seat and hence gives the "correct" output from various sensors and detectors installed to prevent driver exchange, such as door sensors, seat-belt sensors and weight sensors in the seat. The present invention recognises that a useful approach to this problem is to monitor occupancy of the driver's seat by obtaining an image or images which can be used to determine occupancy. In this way, it can be readily determined whether the person occupying the driver's seat is the person taking the alcohol test, and whether that person remains in the driver's seat to drive the vehicle after a successful test. Any exchange of persons can be identified, as can the presence of a second person in the vicinity of the alcohol testing device. Either of these circumstances tends to indicate an attempt to cheat the alcohol test, so the vehicle can be disabled even if it has previously been enabled following an alcohol measurement giving a result below the limit or threshold for the system.

Optical imaging using visible light can be used to monitor occupancy, but may be found to be less versatile than infrared imaging. Passive or active infrared imaging can be used. The latter technique operates by using an infrared source to emit (usually) near-infrared radiation in the direction of the subject to be imaged, and detecting the

radiation reflected from the subject with an infrared camera or other detection device to record an infrared image. Apparatus that operates in this way can be thought of as an illuminated infrared imaging device or system. Passive infrared imaging, or thermal imaging, operates by detecting infrared radiation emitted by a hot body, such as a human being. If a large area infrared detector or an array of small detectors is used, a thermal "image" can be obtained, in which each point in the image records the level of infrared radiation detected from the corresponding point in the field of view of the thermal "camera". The amount of radiation emitted and hence detected is proportional to the heat of the imaged object at that point, giving an image of varying intensity. Often, false colour images are generated, in which red is used to represent hotter, more intense, areas and blue is used to represent colder, less intense, areas, although other colour schemes or grey scale can be used. False colour or grey scale is also used in an illuminated infrared system to indicate the detected intensity of the reflected radiation.

A thermal image of a human recognisably shows a human, in that the hotter part of the image has a human outline (assuming that the background is colder than body temperature, as will generally be the case for a human sitting in the seat of a car). Within the outline, different parts of the body will appear as different colours or intensities in the image, depending on factors such as natural variation in temperature between body parts and the amount of clothing worn. In particular, the head is generally clearly identifiable as a hot part of the image, in line with the relatively high heat loss through the human head. An illuminated infrared image is similar to a regular photographic image (but recorded with light of a longer wavelength) so again the salient features required to identify the presence of a human are readily apparent.

Thus, for the purposes of determining occupancy of a vehicle seat, an infrared image provides the necessary information as would an optical image. However, the infrared image may be more straightforward to analyse. For example, in a thermal image the head of the person will in most cases be easily recognisable as the hottest object in the field of view. For an optical image the head may be less distinguishable

from the background in terms of colour, intensity or contrast alone so that more complex image recognition is needed to process the image. Also, infrared imaging offers the great advantage that it can be used with equal efficiency during the day and at night, since for a passive system a human being radiates infrared heat energy at all times and for an active system the infrared source can emit the required illuminating radiation on demand. In contrast, an optical imaging system will operate poorly in low light conditions, and may fail altogether at night.

An appropriately positioned infrared imaging device can thus record one or more infrared images that can be used to determine occupancy of a driver's seat in a vehicle, and any changes in occupancy that may indicate misuse of an alcohol testing device. In general, a valid test can be considered to have been performed if a single person enters the driver's seat, provides a sample of breath to be tested for alcohol, and remains in the seat after the test is passed and the vehicle enabled for operation (generally enabled for driving), and turned on for use. From the point of view of the imaging system, an invalid test is likely if more than one person is detected in or near the seat, particularly if one person appears close to the alcohol testing device and then leaves, or if one person is detected in the seat and taking the test, but subsequently leaves. In these latter cases, the vehicle can be disabled to prevent use, even if it has already been enabled in response to a valid test. Thus, abuse of the testing system by one person taking the alcohol test and another person then driving the vehicle can be prevented or reduced.

The required occupancy information can be determined from the infrared images in any convenient manner. For a thermal image, the most intense (hot) part of the image will generally correspond to the head, and will hence have a typical size within the field of view of the imaging system. For an illuminated infrared image, the head will again have recognisable characteristics, such as size, shape and facial features. Thus, an occupant's head can be detected and recognised, thus indicating the presence of an occupant in the seat. The location of the alcohol testing device within

the field of view will be known, so that an image of a person providing a breath sample will be recognisable. Similarly, the head moving out of the field of view (occupant potentially leaving the driver's seat) will also be recognisable, (for a thermal image the hottest part of the image will no longer correspond to the image of a head), and the presence of more than one person can also be recognised (for a thermal image there will be more than one typical head "hot spot" in the image). Image processing can be used to distinguish between these various states by identifying features in the image that indicate whether a person is present in the occupancy region. This can take the form of pattern recognition techniques, analysis of individual pixels of the image, or comparison with a library of images of one, two, and more persons in the driver's seat in various positions to find a best match. Neural networks may be used in this context, where the library is used to train the neural network to recognise different occupancy images. Other image processing methods capable of yielding the required information may also be used.

The infrared imaging system can have an image area, or field of view, that at least accommodates an occupant sitting in a driving position in the driver's seat and also in the position required to provide a breath sample for the alcohol test, so that the system can determine that the same person takes the test as sits in the driving position. However, the image area can be expanded to provide for convenience for the occupant, for example by giving the occupant room to shift to a more comfortable position or to reach to various parts of the vehicle before driving off. For the purposes of this description, the term "occupancy region" is used to indicate that part of driver's seat which it is sufficient to image to obtain the required occupancy information from the infrared image. For example, this may give a field of view that includes little more than the input for the alcohol test device and the upper part of the driver's seat, but may be larger to include more of the seat and/or surrounding parts of the vehicle.

Figure 1 shows a schematic representation of the front part of the interior of a vehicle provided with a vehicle safety system in accordance with an embodiment of

the invention. The Figure shows the interior from the point of view of an occupant of the driver's seat, which in this example is on the right of the vehicle. It is to be understood that this embodiment is merely an example; the system may be implemented with fewer or more components, or alternative components.

The vehicle 10 has an infrared imaging camera or detector 12 (plus associated infrared source if an illuminated infrared system is used) mounted in or on the stalk of the rear view mirror 14 (which is in the usual position in the upper central part of the windscreen). This is a convenient position for the camera 12 to command the necessary view of the occupancy region of the driver's seat, but the camera may be mounted elsewhere in the vehicle if preferred. The infrared imaging camera 12 has an associated image processor that is operable to process images recorded by the camera 12 to determine occupancy of occupancy region (nobody, one person, more than one person, as discussed above). The camera and processor together form an infrared imaging device or system. The processor may be integral with the camera, as a single unit or device, or may be remotely positioned in another unit or device to which the camera is connected. The infrared imaging system may utilise any infrared imaging technology that provides suitable images. As mentioned above, this may be a passive (thermal) or active (illuminated) infrared imaging device. For example, infrared microbolometer technology has been found to be useful for thermal imaging. Technology is available that is CMOS foundry compatible and is based on a metal film resistive array technology, which can be used to produce modest sized arrays at extremely low cost due to the relatively few steps in the foundry process. The sensing element consists of a metal film resistance bolometer array. Each element (pixel) of the array comprises a surface micro-machined bridge structure on which is deposited a resistive track. The rise in temperature of the individual pixels changes the resistance of the deposited track and hence by measuring this, the temperature rise of the individual pixel can be measured and a thermal image of the scene obtained. The dimensions of the array are tuned so that it is sensitive to far infrared radiation, but

may be adapted so that near infrared radiation could be employed. Other thermal imaging systems could alternatively be used, however.

In the embodiment of Figure 1, the image processor is provided in a central control unit 16 (such as a central processing unit (CPU)) to which the infrared imaging camera 12 is connected, and which controls operation of the safety system as a whole. The control unit 16 may be a separate dedicated unit (which is useful in providing a system that can be retro-fitted to existing vehicles) or may be incorporated into a computer system that controls other functions of the vehicle. A separate control unit 16 may be located in any convenient place within the vehicle, such as in or under the dashboard.

An alcohol testing device 18 is also provided, and connected to the central control unit 16. In this example, the alcohol testing device 18 is of a type comprising a blow pipe or tube into which a person may blow to provide a sample of air to be tested, a chamber connected to the tube to receive the sample of air, and one or more alcohol sensors inside the chamber which can measure the amount or level of alcohol in the sample. The tube may be removable and replaceable for cleaning and hygiene purposes. The sensor or sensors generate a signal that indicates the alcohol level. This signal can then be compared (using software or a comparator circuit, for example) with a pre-set threshold representing the level of alcohol which a person may have in his system while still being permitted to drive the vehicle. For example, the threshold may be selected to match the local legal alcohol limit for driving, or to be below the legal limit so as to allow for a margin of error, or to be set to zero, for a "zero tolerance" approach to drink-driving. The comparison may be performed in the alcohol testing device 18 or in the central control unit 16. In the former case, the alcohol testing device 18 may have a simple two-state output, indicating either a pass or fail of the alcohol test (the alcohol level being below or above the threshold respectively).

The alcohol testing device 18 is located within the steering wheel 20 of the vehicle, as being a convenient location to allow a person occupying the driver's seat to provide a breath sample. However, other locations may be adopted. Also, other alcohol testing devices may be employed, such as one in which a fan is used to intake exhaled air from the vicinity of the driver to a test chamber for measurement. However, a device of the blow-pipe variety may be preferred as offering a more rigorous test, in that the infrared imaging can more readily monitor and verify the person giving the breath sample.

A vehicle immobiliser device or system 22 is also provided, connected to the central control unit 16. This may be any device that can reversibly enable or disable the engine or other motive apparatus employed by the vehicle, or apparatus which controls the engine or motive apparatus such as an ignition system or other switching arrangement, or apparatus that otherwise relates to whether or not the vehicle can be driven or otherwise operated, such as the brakes, for example. Enablement is putting the vehicle in a condition in which it can be driven or otherwise operated, and disablement is putting the vehicle in a condition in which it cannot be driven or otherwise operated. There need not be distinct and separate actions for enablement and disablement; one state may be implemented by a positive action to set the condition of the vehicle in some way, and the other state may be implemented by not carrying out that positive action. For example, enabling the vehicle may simply be not disabling the vehicle, or vice versa. Given that many vehicles are typically in an operative, enabled state, the immobiliser may operate by reversibly disabling the vehicle. Alternatively, the system may maintain the vehicle in a neutral, "stand-by" state, so that the immobiliser acts positively to enable or disable the vehicle as appropriate. Any arrangement that can perform the required disabling/enabling reversibly can be employed for the immobiliser 22. In this example the immobiliser 22 is operable to enable or disable the vehicle in response to signals sent by the central control unit 16.

Also connected to the central control unit is a display device or unit 24 mounted to be visible to an occupant of the driver's seat, such as on the dashboard. This is operable to display, in response to signals sent by the central control unit, various commands and information to the occupant, such as a prompt to provide a sample of breath to the alcohol testing device 18, and an indication of whether the vehicle is enabled or disabled. This information can be displayed or signalled by the illumination of variously coloured lights or signs, for example.

The vehicle ignition system 26 (or other arrangement by which the driver switches on the vehicle for operation) is also connected to the central control unit 16. Finally, the door 28 on the driver's side of the vehicle (i.e. the door giving access to the driver's seat) is provided with a door sensing device that can detect opening and closing of the door. This is also in connection with the central control unit 16.

Figure 2 shows a schematic representation of the central control unit 16, showing connection to the various components in accordance with the embodiment of Figure 1. The central control unit is operable to control operation of the vehicle safety system by co-ordinating the various components. The relevant functionality of all the components passes through the control unit 16. In this example, the central control unit is a computer processor provided with appropriate software to operate the vehicle safety system. However, the necessary operation could alternatively be provided using any combination of hardware, software or firmware. This could be configured as a central control unit, as in this example, or alternatively (or additionally) various of the components may be connected directly to one another to allow relevant control and command signals and information to pass between components. For example, a direct connection could be made between the alcohol sensing device 18 and the immobiliser 22 so that the vehicle can be immobilised in direct response to a signal from the alcohol sensing device 18 that an alcohol test has been failed.

Figure 3 shows a flow chart illustrating steps in the operation of the example vehicle safety system of Figure 1. When a person intending to drive the vehicle opens

and then closes the door 28 when entering the vehicle and then occupying the driver's seat, the door sensor 30 sends a signal to the central control unit 16, which enters a standby mode in which it is ready to operate the vehicle safety system. The person then turns the ignition system 26 to its first "on" position. This is detected by the central control unit, which responds by switching on the infrared imaging system including the infrared imaging camera 12. The occupancy region of the driver's seat is then imaged by the camera 12, and the infrared image obtained is used by the infrared imaging system to determine the presence or absence of a person in the occupancy region. If it is determined that an occupant is present, and that only one occupant is present, the central control unit 16 sends a signal to the display unit 24 to display a signal prompting the occupant to supply a sample of breath to the alcohol testing device 18, for example by illuminating a sign or indicator light labelled "BLOW". The alcohol testing device 18 is activated for use. The occupant should respond by blowing into the tube of the alcohol testing device 18. The sign is extinguished when a sufficient breath sample has been provided.

Next, the alcohol testing device 18 measures the amount of alcohol in the sample. The measured level is compared to the specified alcohol threshold or limit (either in the alcohol test device 18 or in the control unit 16, as discussed above) to determine whether the test has been passed or failed. If the amount is above the threshold (test failed), the central control unit 16 sends a signal to the immobiliser 22 to disable the vehicle, and a signal to the display unit 24 to indicate to the occupant that the vehicle has been disabled (by illuminating a red light, for example). If the alcohol level is below the threshold (test passed), the central control unit 16 sends a signal to the immobiliser to enable the vehicle, and a signal to the display unit 24 to indicate to the occupant that the vehicle has been enabled (by illuminating a green light, for example). For a vehicle with a normal state in which it is enabled, no positive action will be required by the immobiliser to enable the vehicle, and the "enabling" signal from the central control unit to the immobiliser may be omitted. The occupant

may then turn the ignition system 26 to the second "on" position to start the vehicle preparatory to driving.

The infrared imaging continues. If the test is passed and the vehicle enabled, but the infrared imaging system then detects that the occupant leaves the occupancy region, or exchanges occupancy with a second person, or a second occupant appears in the occupancy region, an abort signal is generated and the central control unit 16 instructs the immobiliser 22 to disable the vehicle. Similarly, if the door sensor detects that the door is opened after the alcohol test is passed, this is communicated to the central control unit 16 which again instructs the immobiliser 22 to disable the vehicle. Also, the system can be arranged such that if any of these "abort" situations occur while the alcohol test is being carried out, or otherwise at a time prior to any enablement of the vehicle in response to a passed alcohol test, the vehicle is disabled.

Following disablement of the vehicle, the vehicle safety system can be re-set to begin the testing process again, to be initiated for example by an occupant setting the ignition system to the appropriate position.

It is not necessary that all of these steps be carried out. According to other embodiments, various steps may be omitted or replaced, or the same function achieved by alternative devices or in an alternative manner. For example, the dashboard display device may be modified or omitted from the system so that the steps of signalling to the occupant to provide a breath sample and/or of indicating whether the vehicle is enabled/disabled or the test passed or failed may not be performed. The integration of the ignition system may be omitted, so that the infrared imaging begins operation directly in response to the door sensor detecting opening and closing of the door. Alternatively, the door sensor may be omitted, and the ignition system relied upon alone to activate the system and the imaging. In the absence of a door sensor, the system can be arranged to disable to vehicle in response to a failed test, a person leaving the occupancy region, or further occupants being detected, but not in response to the door opening after a passed test. Also, the determination of additional occupants

in the occupancy region may be omitted to provide a simpler system, so that enablement of the vehicle relates to the person who is imaged providing the breath sample not subsequently leaving the occupancy region, and not also to the detection of more than one occupant. Use of the testing system may require the occupant to operate a specific control that turns the system on, rather than the system using detection of the door usage and/or detection of an occupant to initiate the testing procedure.

Embodiments of the invention are widely applicable to any type of vehicle, including cars, vans, lorries, trucks, motorcycles, buses, coaches, forklifts, trains and trams, and also non-land-based vehicles such as boats and aircraft. Also, the invention may be adapted for use with machinery or apparatus the operation of which by a person who has consumed alcohol is desired to be prevented. In this case, enablement and disablement relate to enabling and disabling operation of the machine (the nature of which will depend on the function of the machine or apparatus) rather than enabling and disabling driving of a vehicle.

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[3] GB 2,232,284

[4] EP 1,469,414

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CLAIMS

1. An alcohol test-based vehicle safety system comprising:

an alcohol sensing device operable to measure the level of alcohol in a sample of breath provided by an occupant of a driver's seat in a vehicle, the system being operable to disable the vehicle in the event of a level of alcohol measured by the alcohol sensing device exceeding a specified threshold; and

an infrared imaging device operable to image an occupancy region of the driver's seat to determine the presence or absence of an occupant in the occupancy region, the occupancy region including an input of the alcohol sensing device, the system being further operable to disable the vehicle in the event that the infrared imaging device determines that an occupant in the occupancy region who has provided a sample of breath leaves the occupancy region.

2. A vehicle safety system according to claim 1, further operable to disable the vehicle in the event that the infrared imaging system determines the presence of more than one occupant in the occupancy region.

3. A vehicle safety system according to claim 1 or claim 2, further comprising a door sensor device operable to detect opening and closing of a door of the vehicle that gives access to the driver's seat, the system being further operable to disable the vehicle in the event that the door sensor device detects opening of the door after the infrared imaging device has determined the presence of an occupant in the occupancy region.

4. A vehicle safety system according to claim 3, in which the door sensor device is further operable to activate the vehicle safety system in the event that opening and subsequent closing of the door is detected.

5. A vehicle safety system according to any preceding claim, further operable to activate the alcohol sensing device to make an alcohol level measurement if the infrared imaging device determines the presence of an occupant in the occupancy region.

6. A vehicle safety system according to claim 5, and further comprising a display device visible to an occupant in the occupancy region operable to display a signal prompting the occupant to provide a sample of breath to the alcohol sensing device when the alcohol sensing device is activated.

7. A vehicle safety system according to any preceding claim, and further comprising a vehicle immobilising device reversibly activatable by the system to disable the vehicle.

8. A vehicle safety system according to any preceding claim, and further comprising a central control unit to which at least some of the devices comprised in the system are connected and which is operable to control and co-ordinate operation of those devices to disable the vehicle.

9. A vehicle safety system according to any one of claims 1 to 8, in which the infrared imaging device comprises a passive infrared thermal imaging device.

10. A vehicle safety system according to claim 9, in which the passive infrared thermal imaging device comprises an infrared microbolometer array.

11. A vehicle safety system according to any one of claims 1 to 8, in which the infrared imaging device comprises an illuminated infrared imaging device.

12. A vehicle safety system according to any preceding claim, in which the infrared imaging device is operable to determine the presence or absence of an occupant in the occupancy region by obtaining one or more infrared images of the occupancy region and processing the one or more infrared images to identify any image features indicative of the presence of an occupant.

13. A vehicle safety system according to claim 12, in which processing the one or more infrared images comprises the use of pattern recognition techniques.

14. A vehicle safety system according to claim 12, in which processing the one or more infrared images comprises comparing the one or more infrared images with a library of infrared images of occupants in the occupancy area.

15. A vehicle safety system according to any preceding claim, in which the alcohol sensing device comprises a tube into which an occupant of the occupancy region can blow to provide a sample of breath, a chamber for receiving the sample of breath via the tube, and one or more alcohol sensors located in the chamber to measure the level of alcohol in the sample of breath.

16. A vehicle fitted with a vehicle safety device according to any one of claims 1 to 15.

17. A method of controlling a vehicle using an alcohol test, comprising:

imaging an occupancy region of a driver's seat in the vehicle to determine the presence or absence of an occupant in the occupancy region using an infrared imaging device, the occupancy region including an input of an alcohol sensing device;

using the alcohol sensing device to obtain a sample of breath from an occupant determined to be present in the occupancy region;

measuring a level of alcohol in the sample of breath;

disabling the vehicle in the event that the measured level of alcohol exceeds a specified threshold; and

disabling the vehicle in the event that the occupant, having provided the sample of breath, is determined to have left the occupancy region.

18. A method according to claim 17, further comprising disabling the vehicle in the event that more than one occupant is determined to be present in the occupancy region.

19. A method according to claim 17 or 18, further comprising monitoring opening and closing of a door of the vehicle that gives access to the driver's seat, and disabling the vehicle in the event that the door is opened after the presence of an occupant in the occupancy region has been determined.

20. A method according to claim 19, and further comprising commencing imaging the occupancy region in the event that the door is opened and subsequently closed.

21. A method according to any one of claims 17 to 20, in which the level of alcohol is measured using an alcohol sensing device which is activated to make an alcohol level measurement if an occupant is determined to be present in the occupancy region.

22. A method according to claim 21, further comprising displaying to the occupant a signal prompting the occupant to provide a sample of breath when the alcohol sensing device is activated.

23. A method according to any one of claim 17 to 22, in which the occupancy region is imaged using a passive infrared thermal imaging device.

24. A method according to claim 23, in which the occupancy region is imaged using an infrared microbolometer array.

25. A method according to any one of claims 17 to 22, in which the occupancy region is imaged using an illuminated infrared imaging device.

26. A method according to any one of claims 17 to 25, in which determining the presence or absence of an occupant in the occupancy region comprises processing one or more infrared images of the occupancy region to identify any image features indicative of the presence of an occupant.

27. A method according to claim 26, in which processing the one or more infrared images comprises the use of pattern recognition techniques.

28. A method according to claim 26, in which processing the one or more infrared images comprises comparing the one or more infrared images with a library of infrared images of occupants in the occupancy area.

29. A method according to any one of claims 17 to 28, in which measuring a level of alcohol in the sample of breath comprises using an alcohol sensing device comprising a tube into which an occupant determined to be in the occupancy region can blow to provide the sample of breath, a chamber for receiving the sample of breath via the tube, and one or more alcohol sensors located in the chamber to measure the level of alcohol in the sample of breath.

30. An alcohol test-based vehicle safety system substantially as described herein with reference to the accompanying drawings.

31. A method of controlling a vehicle using an alcohol test substantially as described herein with reference to the accompanying drawings.

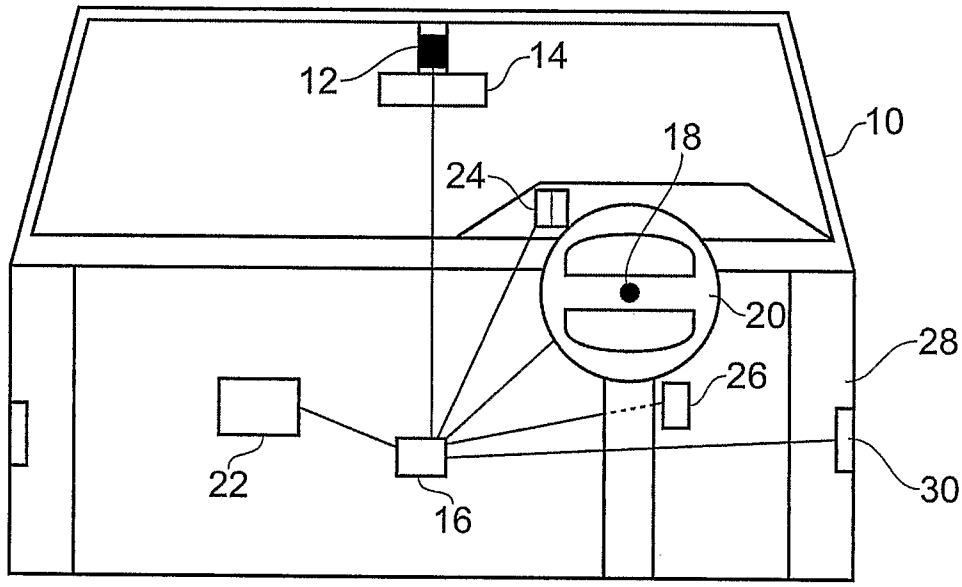

Fig. 1

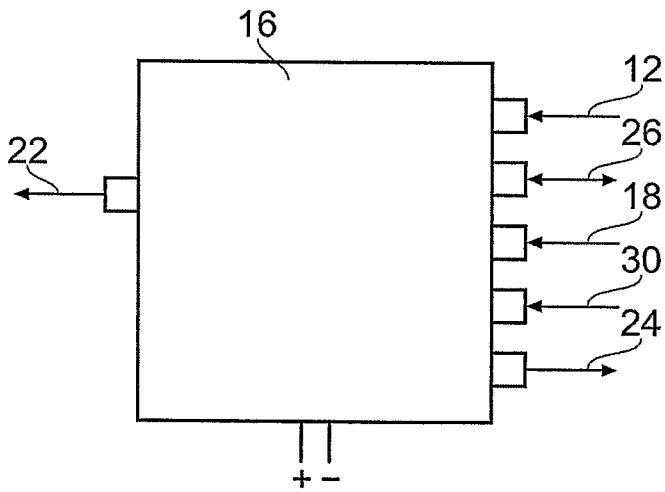

Fig. 2

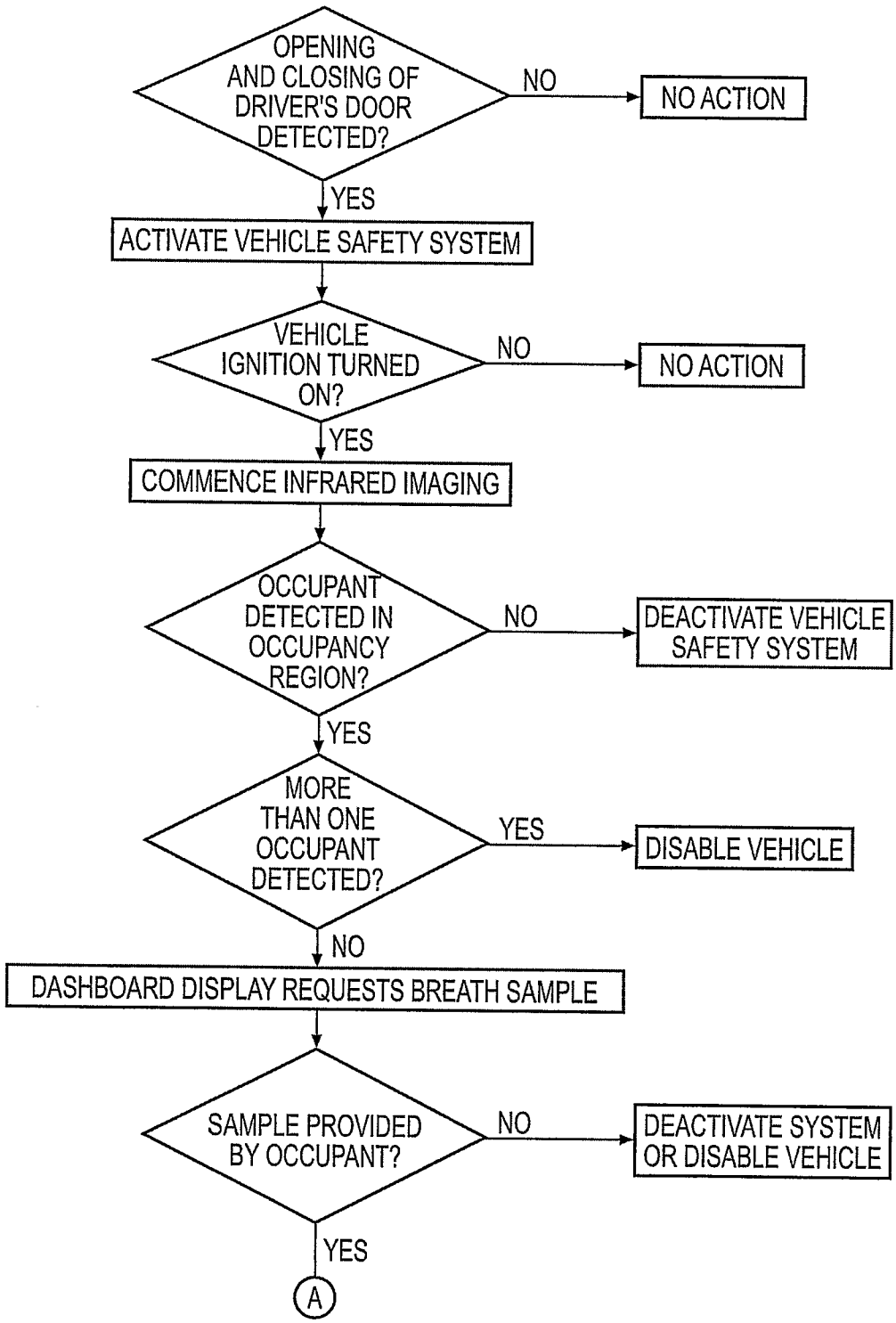

Fig. 3 (continued on page 3/3)

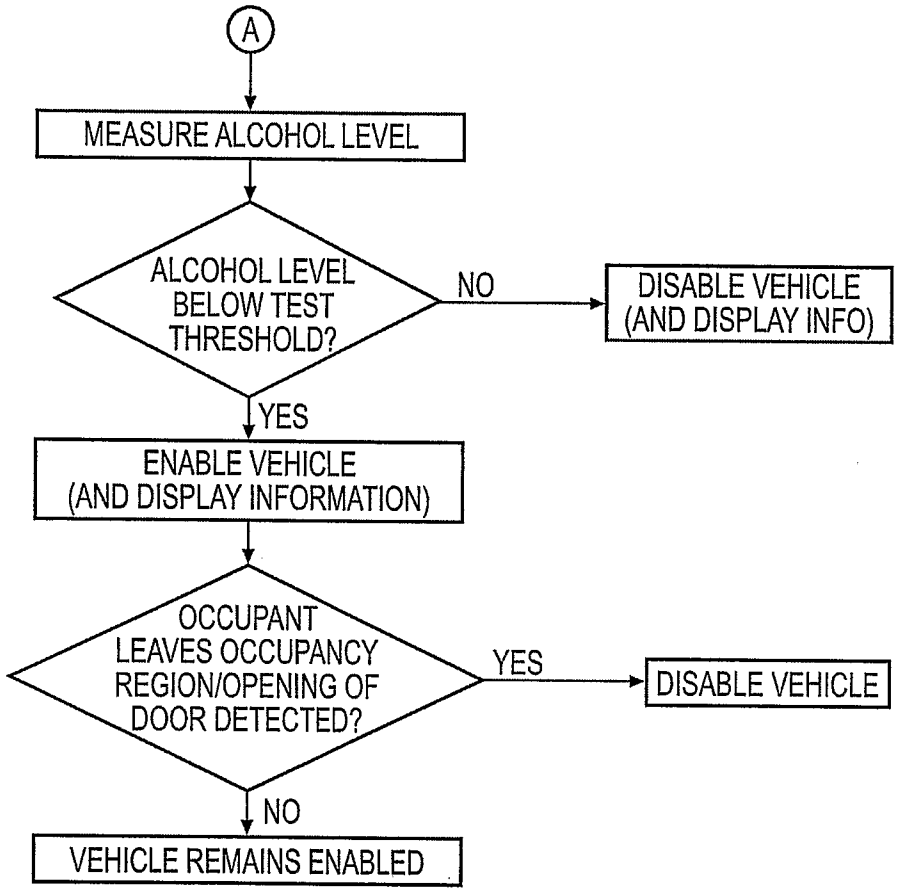

Fig. 3 (continued)

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2006/003669

A. CLASSIFICATION OF SUBJECT MATTER
INV. B60K28/04 B60K28/06

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)
B60K G01N

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

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Y	GB 2 232 284 A (DUCKETT DAVID) 5 December 1990 (1990-12-05) page 1, lines 7-17 page 2, lines 19-22; figure 1	1-31
Y	WO 03/057521 A (CRESPO PIERRE M [US]) 17 July 2003 (2003-07-17) page 10, lines 13-17	1-31
A	WO 86/04869 A (FAIL SAFE BRAKE CORP [US]) 28 August 1986 (1986-08-28) abstract	1-31

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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 :

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Date of the actual completion of the international search	Date of mailing of the international search report
29 November 2006	06/12/2006

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INTERNATIONAL SEARCH REPORT

International application No
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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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Information on patent family members

International application No
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