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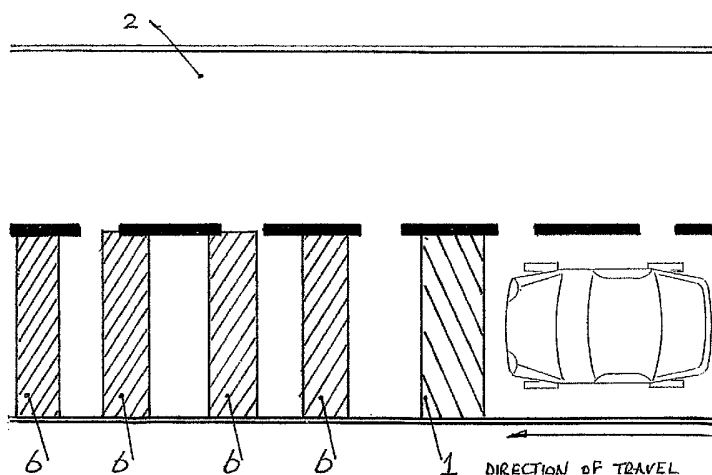
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(54) Title: TRAFFIC INFORMATION SYSTEM FOR ROAD AND RAIL



(57) Abstract: A system for generating a control output signal, the system comprises a vehicle, information carrying means located on a vehicular route, a detector for detecting said information carrying means, and a controller including a processor. The detector generates a detector output signal carrying at least part of the information carried by the information carrying means, and the detector output signal is received as an input to the controller and is processed by the processor to generate the said control output.

TRAFFIC INFORMATION SYSTEM FOR ROAD AND RAIL

Definitions

For the purpose of this invention, a vehicle is defined as a structure mounted on one or more wheels, usually, but not necessarily, designed to operate on a prepared surface. A vehicle may be propelled by an onboard power source e.g. a motor car, or by the application of an external power source e.g. a shopping trolley.

Introduction

The commonest types of self-powered wheeled vehicle are the motor car, the truck or the railway train. This being the case, the description and function of the vehicle control system herein described is centred around, but not confined to, the operation of motor vehicles.

There are two traffic management problems, which demand special attention.

One is exceeding the speed limit, often, but not necessarily unintentionally. The other is unintentional and unadvised traffic lane or carriageway deviation, that is, crossing longitudinal continuous or intermittent markings, generally in the direction of travel, which delineate the available or usable width of a road or carriageway of a multi-carriageway road, for example, a motorway.

It is the intention of this invention to address either or both of these problems in a single system or in two or more separate systems. Either or both systems herein described, although designed to stand alone, may be combined with satellite global positioning technology and/or may employ mobile phone technology for the purpose of system enhancement.

In order to read statutory speed limit signs or other statutory, advisory, voluntary or commercial signs or notices, one or more pieces of apparatus on a vehicle are configured to read and present to the driver of a vehicle, by visual or other suitable means such as voice synthesis, speed limit or other statutory or commercial data of whatever type and however

presented on the basis of dead reckoning. The actual and virtually instantaneous speed of the vehicle may also be determined with or without reference to the vehicle speedometer reading. The average speed of the vehicle over a period of time, available from the system clock or the vehicle 12/24-hour clock over a discrete distance may be computed, and the absolute accuracy of the vehicle speedometer may also be ascertained. The virtually instantaneous speed or the average speed of a vehicle over a discrete distance may be compared with the statutory, voluntary or temporary speed limit and the driver informed accordingly. This data may be advised automatically to a driver by audio (e.g. voice synthesis) or visual means thus minimising consequential driver distraction.

Various methods of informing the driver of a vehicle that he or she is exceeding the speed limit have been developed or have been proposed. The latest of these devices requires the driver of the vehicle or a passenger to enter the applicable speed limit, currently, but not necessarily, ascertained visually, in analogue or digital format into an apparatus fitted to a vehicle, often interfaced mechanically and/or electrically with the vehicle speedometer, and usually, but not necessarily, whilst travelling. Thus a visual or audible notification of significant deviation from the speed limit in a positive or negative sense may be achieved. The allowable deviation may be preset by the manufacturer of the apparatus or it may be adjustable by a statutory authority (e.g. as part of vehicle examination at a Government test station), by the vehicle dealer or even by the vehicle driver him or herself.

These aids which, by design, are activated voluntarily actually do little to alleviate driver distraction which this current invention attempts to address. The proliferation of, and improved enforcement procedures for, contravention of speed limits and other statutory regulations, the desirability of minimising driver distraction, the established connection between speed and road accidents which impose strain on national resources render some improvements in traffic management imperative.

The present invention acknowledges the existence of systems in which the position of a vehicle may be identified by a satellite positioning system and then be compared with an electronically generated road map, which identifies speed zones and any other statutory or commercial information. The zonal map has to be updated by a central or regional authority at regular intervals.

The present invention could compliment a satellite or mobile phone based system by introducing the concept of dead reckoning to traffic control systems. As a minimum, this invention aims to address speed limit violations and/or erratic driving of land based vehicles, particularly cars and trucks, by significantly reducing the effects of driver distraction and inattention thus improving road safety.

Description of the invention

A number of methods of executing this invention for the sake of clarity and brevity appear in Appendix 1, whilst the optical method is described in detail hereinafter. All the methods achieve the same basic result, that is, reading digital, usually coded or analogue data from the roadway or it's environs from inputs, optical, radio frequency, magnetic, electronic or other means and conveying the information to the driver of a vehicle. Alternatively the retrieved data may be stored in, or transmitted from the vehicle and/or employed to adjust the vehicle operating system.

Fig [1] shows the apparatus (3), which is fitted to a vehicle moving in the direction indicated over a road (2) to which code lines (1) and (6) have been affixed.

Fig [2] shows a vehicle travelling on a two-way road and approaching code bar (1) and bars (6).

Fig [3] shows a two way road where a vehicle is approaching code bar (1) and alternatively or additionally code bars (6) which are preceded by 'alerting' bars (7) which alerts the apparatus to read the subsequent code bars. It also shows how the code bars (8) may not be straight or parallel to one other.

Fig [4] shows a vehicle about to traverse alerting bars (7) followed by a single bar (1) or multiple bars (6) at other than the design angle, which in this case is 90 degrees to the direction of travel.

Fig [5] shows the error, which is generated for a basic coding system when a vehicle is travelling along the hypotenuse instead of the long side of a triangle where the angle of the long side is 90 degrees to the code bars.

Fig [6] shows an example of a standard or special bar code (12).

Fig [7] shows a section of a two-way road with double lines, usually, but not necessarily, white, in the centre of the road (15, 16, 17) with a 'no drive' area (14) and parking lines or similar at the side of the road (13).

Fig [8] shows a diagrammatic layout of the system.

Fig [9] shows 'normal' lane lines (27) coded by virtue of their size and position relative to each other (28). Discrete devices, either reflective or powered, are shown (29) set into or onto the road surface.

Fig [10] shows elements of lane lines which themselves constitute a code (30), but also delineate the useable part of a road or a lane on a multicarriageway road. Fig [10] also shows a single continuous or intermittent line (31) running the whole or part length of a single road or carriageway usually midway between the lane delineating lines (30).

Fig [11] shows an example of coding elements of lane delineating lines (32, 33, 34) in which one or more elements may be specified to complete the code.

The primary object of this invention is to read coded or non-coded, digital or analogue data from anywhere on the road surface or from index marks on either or both sides of the road or on either or both kerbs or verges by one or more pieces of apparatus mounted on or incorporated into a vehicle. Transmission of the coded data from the roadway and/or its environs or from other fixed points relative to the roadway may be by RF, ultrasonic, acoustic, video, magnetic, electromagnetic displacement transducers, radar or optical means or by a combination of any or all of these means. The data may be interfaced with inputs from global positioning systems or mobile phone technology. The optical means may be direct from a primary light source e.g. LEDS or electroluminescent elements on/or incorporated into a road surface, or it may be reflective, differentiating between the code lines or bars and the surrounding area of the road surface.

By way of example a reflective optical system is herein described Fig [1] in which a basic version of the system consists of one bar, line or stripe (1) applied to or incorporated into a road surface (2). The bar is detected by one or more pieces of apparatus (3) mounted on or incorporated into a vehicle. The apparatus (3) incorporates a visible or invisible e.g. infrared light source (4) and a photosensitive element (5), which may be directed at any convenient angle to the roadway but usually at 90 degrees. A single bar (1) or a multiplicity of bars, lines or stripes (6) mentioned hereinafter may be of any suitable width and would usually extend at an angle between 0 degrees and 90 degrees to the direction of travel, from one side of a traffic lane, roadway or carriageway to the other Fig [2] (1) and (6) and Fig [6] (12). The lines, bars or stripes which are continuous or intermittent are applied to the road surface or are incorporated into the road surface permanently, semi permanently or temporarily in such a way and of such material that the maximum contrast between them and the surrounding road surface is achieved. The lines or bars may be printed or otherwise applied to a solid or flexible medium e.g. plastic, which is subsequently attached e.g. bonded to the road surface. It may extend for part or for the whole width of the road, lane or carriageway. The apparatus on a vehicle may also be configured to read existing GATSO speed camera markers or any similar equipment. In its basic form the code is represented by a single line, bar or stripe Fig [1] (1) of different widths in the direction of travel according to the speed limit. The traverse time is integrated with the vehicle speedometer reading and the width of the bar or line (1) to calculate the speed limit for that zone. Two or more separate bars, lines or stripes in Fig [1] (6) may be substituted for the single bar or line and again the speed limit is then calculated by integrating the reading of the vehicle speedometer and the traverse time; in a two bar system for example, from a point on one bar to the equivalent point on an adjacent bar (6) or to any other bar (6) in the system. There may be several bars in a single system, which can provide a cyclical verification check Fig [2] (6). In order that the code bar or bars are not read by apparatus mounted on a vehicle travelling against the traffic flow e.g. by an overtaking vehicle in Fig [3] the one or more code bars (1) or (6) are preceded in the direction of travel by a bar (7) or assembly of bars (7) which are unlike any code bars used in the system e.g. multiple narrow bars (7) which alert the apparatus to read the following code bars, see Fig [3] (1) and (6). Hence if the apparatus mounted on a vehicle does not recognise the alerting bars or lines (7) in advance of the code bars, lines or stripes, the code bars (1) and (6) are ignored by the apparatus (3) and its attendant control unit (18) hereinafter

described. The apparatus (3) and associated equipment would normally inform the driver of a vehicle in advance of the speed limit zone thus enhancing safety and ensuring that he or she does not enter the limit zone at an excessive speed.

Depending on the complexity of the coded data and the reading apparatus, some or all the lines or stripes comprising the code may not be necessarily straight or even parallel to each other. The code may consist of some or all non-parallel or curved bars, lines or stripes, Fig [3] (8), and a vehicle is fitted with effectively two or more readers (3) at a standardised distance apart, then the available number of combinations of the code and/or improvements in data verification could result.

The basic system, whether or not it is based on one or more bars, lines or stripes, is dependent on the reasonable accuracy of a vehicle speedometer e.g. 5 - 10% depending on the speed of the vehicle. The speedometer may be itself automatically verified and its accuracy recorded, if required. If a vehicle traverses the code bar or bars (1) and (6) at an angle other than the design angle, Fig [4], a small error is introduced which is the difference in length between the hypotenuse (9) and the longer side (10) of a right angle triangle, the included angle (11) of which is 10 degrees in the example shown in Fig [4] and Fig [5]. The error in this example would be approximately 1.6% or 0.5 mph in 30 mph. The error could be reduced by having the vehicle traverse two or more sets of lines (6) Fig [2] and Fig [4], then the shorter time would be the applicable traverse time.

A more sophisticated code e.g. a special bar code or arrangement of lines of differing widths and/or distances apart, e.g. Fig [6] (12), would not only eliminate the error produced by the basic code system described earlier (Fig [2] (1) and (6)), which is dependent not only on the reasonable accuracy of the vehicle speedometer, but is subject to the error introduced when the vehicle traverses the code lines, bars or stripes at other than the design angle.

A special bar code Fig [6] (11) could be asymmetric in which case the alerting lines (7) would be unnecessary as it would not be possible to be read by apparatus (3) traversing it in the wrong direction. Input from the vehicle speedometer would be unnecessary but its accuracy may be verified and advised to the driver if desired. The piece or pieces of apparatus (3) reading a standard bar code or a bar code developed specially for the purpose of this

invention e.g. Fig [6] (11) and the accompanying control unit (18) (hereinafter discussed) could be configured not only to read and decode speed limits, but also to decode almost any other statutory, advisory and/or commercial data.

Incorporation of significant additional memory, real time clock, data processing and storage facility (e.g. RAM, floppy disk, hard disk etc) would enable the apparatus (3) and control unit (18) to read, process and store other parameters in connection with the operation of a vehicle e.g. speed in speed limit zones, the number and duration of speed limit violations and where they occurred, mileometer discrepancies etc. In addition, data not directly connected with vehicle operation read by apparatus (3) and processed by control unit (18) could be accommodated.

The apparatus (3) mounted on or integral with a vehicle is configured to read continuous or intermittent bars, lines or stripes of any colour or areas of substantial uniform colour, anywhere on the road surface (2) or incorporated into the road surface e.g. denoting parking restrictions Fig [7] (13) or on the kerbs or verges, and to be able to distinguish between different colours e.g. yellow, red, white etc. and whether or not the lines are double or single and if double whether or not one or both elements of a pair are similarly configured.

The apparatus (3) may also recognise cross hatching Fig [7] (14) i.e. a repeated pattern of elements, usually regular, which by way of example may be lines, bars or stripes on/or incorporated into the road surface or any other representation of a 'no drive' area or other statutory directives.

The apparatus (3) may also be configured to track a continuous or intermittent line usually on either side of a road, lane or carriageway, or indeed anywhere on the road (for example (31) in Fig [10]). Referring to Fig [7], the apparatus (3) mounted on a vehicle may be configured to track a continuous (or intermittent) line (15) (in Fig [7]) and (31) in Fig [10] on the surface of or incorporated into a roadway. Such a line may be paired with an intermittent line (16) or a second continuous line (17) in proximity. In Fig [7] a right hand drive vehicle (configured for the UK) is proceeding along one lane of a roadway. In this example the vehicle is prohibited by UK law from crossing the continuous line (15) for example when overtaking except under exceptional circumstances but should this occur, a

warning sound can be emitted or a visual signal may be displayed to the driver. The apparatus (3) is configured to differentiate between a continuous and an intermittent line (15) and (16), even when they are in pairs and close together. If the intermittent line (16) is nearer to the vehicle than the continuous line (15), no warning signal will be generated.

Whatever data collection system from the roadway or its environs is adopted, the onboard apparatus remains locked on to the last speed limit input, which is stored in the memory of the control unit (18) and changes only when the apparatus receives a further input. The apparatus continues to monitor the speedometer reading comparing with the last speed limit data input. It is therefore unnecessary to monitor speed limits continuously either by repetition of data inputs from codes, on or incorporated into the road surface, or visually, throughout the speed limit zone. If a vehicle is parked in a speed limit zone, the apparatus retains in memory the last speed limit data until another input is received.

In order to minimise spurious inputs into the system, the speed limit markings are sited away from other road markings and the following safeguards are put in place.

- (i) The apparatus does not operate when a vehicle is moving forward at less than a predetermined speed e.g. 15mph.
- (ii) The apparatus does not operate at all when the vehicle's reverse gear is engaged.
- (iii) Each line or group of lines or bars which may or may not constitute a conventional or special bar code is unlike any other road marking used in that particular territory.

The aim would be to standardise markings throughout the world. Both a basic or a more complex coding system could inform the driver of a vehicle if he or she was, for example, approaching a one way prioritized road, a dangerous junction, traffic lights, temporary roadworks, a roundabout, a school or hospital or any other situation requiring intensified attention from the driver.

The apparatus (3) with control unit (18) can also be used to input information into a vehicle for the purpose of directing drivers to supermarkets, petrol stations and the like or simply for advertising purposes.

Apparatus for reading lines on or incorporated into the road surface is known (ref. Iteris Autovue, Volvo Car Company; US and other patents and published literature). The purpose of that equipment is to track lines usually, but not necessarily, intermittent, which delineate lanes on a road or highway. Similar equipment could also read the proposed code lines, bars or stripes at 0 - 90 degrees to the direction of travel (but normally 90 degrees) and interface the coded data by suitable means with the vehicle speedometer. Thus two separate functions i.e. signaling unintentional lane deviation and reading speed limits and other statutory or commercial data from the road can be combined.

One or more pieces of apparatus (3) mounted on or integral with a vehicle communicates with a control unit Fig [8] (18) which may or may not be integral with the reading apparatus (3). The control unit (18), which contains among other features a memory facility (e.g. RAM) and a real time clock, processes the incoming data in the basic system essentially from the vehicle speedometer (19) and outputs data, in particular speed limit data (20) for that zone, to the driver of the vehicle. The actual vehicle speed, which can be calculated from the time taken to traverse the code line or bars, is compared by the control unit (18) with the vehicle speedometer reading (19). Any discrepancy may be advised to the driver. If positive over-speed is recorded i.e. speed in excess of that pre-programmed into the control unit (18), including a tolerance if any, the driver can receive an audio signal e.g. a buzzer Fig [8] (21), a voice synthesizer (22) or a visual signal (23).

In cases of vehicle over-speed relative to the applicable speed limit, a signal is generated to interface with the vehicle's engine management or variable ratio transmission system (24) e.g. cruise control, which can slow the vehicle to the value dictated by the speed limit or to any other value. A statutory authority could install temporary or permanent code lines or bars, which could advise a driver of overriding changes to the normal speed zone for that area e.g. to slow traffic through road works or for other statutory or commercial reasons. GATSO or similar speed camera markers could also be recognised in order to warn a driver of their presence, but also to determine the actual vehicle speed over a group of lines. The data thus obtained could be stored electronically on the vehicle or transmitted via a dedicated or multiplexed mobile phone system. The data store, which may be non-erasable, might then be accessed in whole or in part by a statutory authority, the vehicle dealer or manufacturer or even by the driver of the vehicle.

Any or all of the inputs and outputs to the control unit (18) including discrepancies in the vehicle instrumentation could be presented in the form of a print out and/or be stored temporarily or permanently in memory. This information may or may not be accessible in whole or in part to a driver or owner of a vehicle but may be accessible to, for example, a statutory authority.

Commercial organisations could install code lines or bars on a private road or on public roads by permission licensed from the Highway Authority to supply commercial, directional or advertising data to vehicle drivers.

Installation of a speedometer into or onto a vehicle in such a manner that is easily readable by drivers of following vehicles has been suggested. This invention enlarges on that concept to embrace speed limit readings instead of, or additional to, the externally visible speedometer. The speed limit for the zone may be displayed in visual form, analogue or digital (26).

The concept of identifying and tracking lane markers on a roadway, especially a multilane highway is known. The object of such a system is to advise the driver, usually, but not necessarily, by audio means, if he or she deviates from a traffic lane unintentionally. To achieve this, one, but preferably at least two, pieces of apparatus are mounted on or built into a vehicle.

An enhancement of the present invention proposes to extend the scope of a lane tracking system. The intermittent lines or stripes Fig [9] (27) applied to the road surface (2) normally delineating traffic lanes and/or sections/areas of road allocated to vehicles are usually, but not necessarily, of uniform size, longitudinal and parallel to the direction of travel. According to the present invention, the elements of delineating lines may be of different lengths and/or widths or disposition one to another (Fig [9] (28)) and of any colour, on either or both sides of a traffic lane or road or on its kerb or verges to create a coded pattern. The elements of the system may be made from flexible or rigid reflective (e.g. fluorescent) material bonded to the road surface. Alternatively they may be in the form of discrete elements (29) which may be reflective (e.g. cats' eyes) or they may contain a primary source of illumination e.g. LEDs formed into or attached to the road surface. Alternatively

the elements may be formed into or attached to the road surface to provide largely horizontal perturbations (e.g. Rippleprint) which can be detected acoustically by the driver or by an acoustic transducer fitted onto or into the vehicle. Thus the two different functions i.e. signaling unintentional lane deviation and reading speed limits and other statutory or commercial data from codes on the road surface, or the environs of the road e.g. on kerbs or verges, could be combined.

The detection of an event in which a vehicle crossing or partly crossing a continuous, intermittent repeating and/or coded traffic lane-delineating line is a vital ingredient of an unintended lane departure system. One or more sets of vehicle mounted apparatus, usually one on each side, are arranged to read the codes, markers etc. on the road, however presented i.e. optical, magnetic, LEDs etc. Their outputs are combined to advise the driver if he or she is off centre by a preset and/or adjustable amount between the elements delineating a road, lane or carriageway. Alternatively, a single array of lines, bars or stripes generally in the direction of travel, either on or within the road surface may be installed between the lines or markers delineating the available width of a road, traffic lane or carriageway. Such a single array could, for example, consist of a single, but substantially continuous element (31) in Fig [10] which may be detected by one or more pieces of apparatus attached to the vehicle, which are configured to continuously receive inputs from that single element. The apparatus or pieces of apparatus would normally be attached in a standardised position (generally central with respect to the width) on each vehicle. Lateral deviation of the vehicle exceeding a preset and/or adjustable amount may be detected and hence significant deviation of a vehicle from the intended course could be pre-empted.

Either of the above lane following systems may be interfaced with a vehicle steering, engine or transmission management system for example to modulate the vehicle direction or reduce the vehicle speed.

Lane delineating lines which are normally on either side of the traffic lanes of a highway or either side of a road, or a tracking line or lines which may be anywhere on a road, the kerbs or verges are comprised of individual elements. These elements are similar and some or all of them could contain a complete code or part thereof consisting of bars, lines or stripes Fig [10] (30). In the latter case, one element Fig [11] (32) or several elements Fig [11] (32), (33),

(34) may be needed to complete a code. One or more pieces of apparatus (3) already described reads the codes and the control unit (18) decodes them. The codes may be verified by repetition to provide a cyclical reducing verification check.

It may be seen that integrally coded elements may be combined with an arrangement of elements of differing lengths, widths or disposition one to another to form a comprehensive code with the object of determining speed zones or any other statutory or commercial information or they could be integrated with lines or bars usually at 90 degrees to the direction of travel as has been described previously.

For reasons of completeness, further embodiments of this invention employing other techniques for reading data in or on the environments of the road are now described.

Embodiment (I)

Frame grabbing

A line-scanning camera is mounted on or incorporated into a vehicle. The camera is directed at a sign (hereafter called the object) which contains information about speed limits and/or statutory or commercial information. The object may be applied onto, or incorporated into a road surface or fitted, preferably at a standardised height, to a fixture at the side of the road, traffic lane or carriageway or it may be fitted overhead. The data collected by the camera apparatus is compared to that contained in the memory of the control unit in a vehicle. The camera may be swiveled or transversed in any direction at a speed determined by the vehicle speedometer so that in any finite period of time the relationship of the camera image to that of the object is static. The camera may be configured to 'home in' on a continuous or intermittent radio frequency (RF) or ultrasonic beam or a mobile phone transmission emanating from the appropriate sign.

The information may be in code or, for speed limits for example, it could appear in the form of visually readable numerals e.g. 10, 20, 30, 40, 50, 60, 70 etc. miles per hour. When the information has been decoded by the control unit on the vehicle, it is employed in a similar

manner to that already supplied for the optical reading apparatus which reads and decodes lines, bars and stripes on the surface of the road.

Embodiment (II)

A RF transmitter in the environs of the road, lane or carriageway.

- 1) In an analogue system, the speed limits correspond to particular transmitter frequencies which are decoded by the receiver and associated equipment in a vehicle.
- 2) To improve the versatility of the analogue system, the transmitter signal could be modulated or pulsed to provide a simple code which would then be decoded by the receiver and associated equipment on a vehicle. This additional information may be statutory or commercial or simply routine data.
- 3) To yet further improve the system the transmitted signal may be digital and additionally or alternatively may be delivered in bursts. The apparatus on the vehicle decodes the information and employs it in the same manner as the optical system.

To execute concepts 1, 2 and 3 immediately above, the static transmitter may be:

- a) On the side of the road, traffic lane or carriageway, temporarily or permanently.
- b) Above a road, traffic lane or carriageway.
- c) Set into and level with the road surface but protected by a solid or perforated plastic grid (non-conductive).
- d) Set in the kerbs or the verges.
- e) Installed where possible in the central barrier of a dual carriageway or motorway.

The receiving apparatus on the vehicle may be static or it may swivel or transverse in any direction to align itself with the strongest signal from the transmitter.

The transmitter may be solar powered and it may only be active when turned on by approaching traffic or by a time clock.

The receiver, which in any case would normally interface with the speedometer and mileometer (ref. the optical system), employs the vehicle speedometer reading to introduce a compensation for the Doppler Effect, if required.

Embodiment (III)

A RF reflective target in the environs of the road, lane or carriageway.

In this concept, a RF transmitter/receiver is installed in a vehicle and is automatically aligned by reason of its standardised position at any finite moment in time in the general direction of a RF reflective target. The target is also fitted in a standardised position and may be in a similar position to a transmitter described in embodiment (II). The RF transceiver in the vehicle is able to align itself in any direction to adopt a position where it receives the strongest reflected signal. It may now, at any instant of time determine the code on the target or it may be used to scan the target. In either case the code is read and decoded by the control unit in the vehicle. If required, a correction may be necessary to offset the Doppler Effect and this is made in conjunction with the vehicle speedometer.

Embodiment (IV)

The output from a RF generator mounted on a vehicle is directed at static markers which may or may not be specifically designed to be reflective to a RF signal on the side or sides of the road, traffic lane or carriageway or overhead. The markers may be on or impressed into the road. The distance apart, or the particular arrangement and number of the markers, determine the speed limit for that zone and other statutory or commercial information.

Embodiment (V)

A RF generator is fixed at one or both sides of a road, traffic lane or carriageway and emits a signal at a frequency, which is dependent on the particular speed limit for that zone. A RF generator mounted on a vehicle scans the entire frequency band allocated to the representation of speed limits and when a coincident frequency is detected, the speed limit is determined. The data may be employed in a similar manner to that in the optical system.

Embodiment (VI)

One or more programmable or non-programmable transponders are set into the road in such a position(s) whereby it/they is/are traversed by a vehicle. They may be mounted on fixtures on the side of the road, traffic lane or carriageway. The transponders are read by a transmitter/receiver mounted in or on a vehicle.

As the read range of a passive tag is limited, under worst case conditions to about 2 metres, this invention introduces the concept of a short-term active tag. Such a tag has a much greater read range than the passive tag type, but with the advantages of a passive tag. A modified transmitter provides the power to turn on what is essentially an active tag with a short-term power source consisting of a capacitor/resistor network. The power to turn on and charge up the tag's power source is provided by a signal from the transmitter which is powered by the vehicle's electrical system. This signal is provided by one of the several devices, heretofore discussed, ranging from lines and bars on the road to a RF beacon, which would be in advance of the transponder station. The transponder may provide an almost unlimited amount of data, which, when decoded, is presented to the driver and/or placed in short or long term memory for subsequent limited or unlimited access.

Application of the system specifically to trains

The systems heretofore described for road vehicles, particularly those based on coded passive reflective optical devices or on coded programmable or non-programmable LEDs,

are equally applicable to trains. Coded data, whether permanent, semi-permanent or temporary at the side of or within the area between the rails of the track alerts the driver to speed restrictions or other temporary hazards or permanent information via apparatus carried on the train. Over-speed, or if necessary, under-speed data could be linked to the train control system for automatic control. Data could be relayed to the nearest signal box or control centre identifying the position of the train.

APPENDIX I

By way of example, five significant enhancements of the invention are briefly described as follows:

1. Reading commercial information, traffic direction signs (temporary or permanent) or any other statutory data, for example white or coloured lines in all formats, the proximity of parking restriction lines, no drive areas, bus lanes etc.
2. Automatic control of the vehicle speed in line with speed zones by, for example, regulating the speed of the power source or by adjusting the transmission ratio between the power source and the driven road wheels.
3. Interface with and enhancing the scope and versatility of a satellite positioning system by, for example introducing the element of dead reckoning.
4. Providing the facility for variable speed limit data, for example in the proximity of schools or factory areas at certain times in a 24-hour period. This facility may be provided by interfacing the system clock or even the 12/24 hour vehicle clock with the apparatus which is configured to read enhanced coded, speed limit data from the road or its environs, and varying the data output according to the actual time in any 24-hour period.
5. Employing coded data from the road or its environs, which is capable of variable interpretation when combined with the input from one or more mobile phones, which may be dedicated to the speed limit etc. system or may be multiplexed to provide its normal function of speech, text messaging and picture transmission together with data advising changes in interpretation of the speed limit data input or other statutory or commercial data coded on the road or its environs.

APPENDIX II

Following are descriptions of alternative methods of implementation of this invention, that is, reading coded information on or within the road surface or its environs.

1. Perturbations in the road surface

The lines, bars or stripes are represented by depressed or raised portions formed into or onto the road surface when it is possible to readily detect vertical perturbations of the unsprung part of a vehicle suspension or even within the sprung portion of the vehicle structure itself by means of, for example displacement transducers or accelerometers or a combination of both. The resulting data is collected and decoded by an apparatus in a similar manner to that described for the optical recognition system. Predominantly vertical perturbations may be detected acoustically by a receiver positioned on or in or attached to the vehicle structure or its unsprung suspension elements. Predominantly horizontal perturbations may be induced by forming the lines, bars or stripes in accordance with a formula developed by the Road Research Laboratory, one example having the name of 'Rippleprint' mentioned earlier. The 'Rippleprint' formula may be formed into the road surface or can be formed into a material, which may be attached to the road surface subsequently. 'Rippleprint' induces predominantly horizontal perturbations which provide enhanced noise into a vehicle structure whilst minimising external noise to the environment. The perturbations within the vehicle structure may be detected by displacement transducers or accelerometers or by an acoustic receiver.

The data is collected and decoded in a similar manner to the optical line recognition system. 'Rippleprint' is the trademark of a particular manufacturer. Any material, which induces predominantly horizontal perturbations to a vehicle structure and/or its suspension elements, may be used to execute this embodiment of the invention.

2. Magnetic field detection

Permanent or electromagnetically energised elements are installed in, on or beneath the road surface to form bars or stripes usually, but not necessarily, traversing the road normal to the direction of travel in a similar configuration to the reflective optical system.

The change in magnetic field strength as a vehicle passes over an element is detected by a modified tyre pressure indicator and/or other RF transmitters attached to one or more of the wheels or located within the wheels, the tyres, the tyre valves or wheel balance weights. They normally transmit tyre pressure data to a receiver within the vehicle, but their output may be multiplexed together with tyre pressure or any other data e.g. air temperature at road level, depth of water, snow on the road or displacement transducers or accelerometers detecting lateral displacement of a wheel or tyre relative to the road surface. An algorithm may be developed to analyse the data from the apparatus; in particular the configuration, width and disposition of the lines, bars or stripes. By using magnetic paint for the transverse lines or the lines in the direction of travel delineating the boundaries of a road or carriageway, erratic driving or unintended lane deviation may be detected and advised to the driver accordingly.

By way of example a modified and enhanced tyre pressure monitor or other RF transmitter may incorporate a coil which, because when it is moving relative to a magnetic field, permanent or electromagnetically generated, has an electromagnetic force (EMF) induced into it from elements on or in the environs of the road. This event is multiplexed with other information emanating from the tyre pressure sensor and received by a modified apparatus, which is designed primarily to continuously record tyre pressures. If the vehicle is stationary in the proximity of the magnetic or electromagnetic field then the presence of that field may be detected by the suitably modified and enhanced tyre sensor pressure transmitter or a transmitter dedicated to the particular task. By the installation of a permanent or electromagnetic element into a part of the vehicle body structure e.g. a vehicle mudguard, a further enhancement would allow the revolutions of any particular wheel to be ascertained. Installation of an accelerometer or pressure transducer into the tyre pressure sensor and transmitter may be employed to measure the lateral i.e. at 90 degrees to the direction of travel, force on the periphery of the vehicle wheel (e.g. detecting an onset of a loss of

adhesion of a tyre to the road surface) for example generated by cornering or traversing a surface, which generates a lateral force and/or displacement (e.g. the commercial product 'Rippleprint').

Modified tyre pressure sensors or other-dedicated sensors may also be employed to transmit data about a vehicle and its operation (e.g. speed) to receivers on the side of, in or over a road or carriageway in addition to receivers within the vehicle.

3. Metal detection

Passive metal elements are attached to or built into the road surface to represent bars, lines or stripes as in the optical system previously described in full.

The presence of these passive elements is detected by a search coil attached to each vehicle, since the magnetic field is thereby distorted. (Using metal detection technology.) The information is then processed in the same manner as for the optical system.

4. RF field detection

A bar, line or stripe as discussed in the optical system consists of a loop of conductive material which extends across all, or part, of a roadway or carriageway. The loop is powered by a digital signal or a continuous RF signal, or a combination of both, to constitute a code. The composition of either may be varied according to the data being conveyed to the vehicle driver. Typically the signal could be received by modified and multiplexed tyre pressure sensor transmitters. Hence a single bar, or for verification, a multiple bar code array may be employed to encode virtually any data, statutory or otherwise, to the driver of a vehicle.

Adjustment to the input to the loop will modify the data e.g. to advise of variable speed limits and any other statutory or commercial data.

5. Pressure pads

Pressure pads that react to any significant weight of a vehicle passing over them are attached to or set into the road surface. They may be similar to those devices for counting traffic with mechanical or solid state switching. When pressure is detected, a RF transmitter at the side of the road or carriageway sends a signal to a RF receiver installed in each vehicle. This may be a receiver already employed for tyre pressure sensing or any other duties.

The system advises the presence and configuration of lines, bars or stripes coded in exactly the same way as the optical reading system described previously.

In a further embodiment, pressure applied to a pad compresses a PIEZO electric device which delivers an EMF to a transmitter within or external to the pad which then communicates with, for example, a transmitter/receiver attached to one or more wheels (these may or may not be devices normally performing other duties such as tyre pressure monitoring). Alternatively the transmitter in the pressure pad may communicate directly with a receiver within or attached to the vehicle structure, which may, for example, normally monitor tyre pressures.

Improvements in road and rail traffic control**Claims**

1. A system for generating a control output signal, the system comprising:
 - i) a vehicle;
 - ii) information carrying means located on a vehicular route;
 - iii) a detector for detecting said information carrying means; and
 - iv) a controller including a processor,wherein the detector generates a detector output signal carrying at least part of the information carried by the information carrying means, and wherein detector output signal is received as an input to the controller and is processed by the processor to generate the said control output.
2. A system as claimed in Claim 1, wherein the mode of operation of the detector is selected from the group comprising: optical, radio frequency, magnetic, electromagnetic, electronic, acoustic, ultrasonic, infra-red and video.
3. A system as claimed in Claim 1 or 2, wherein the information carrying means comprises a code.
4. A system according to any preceding claim, wherein the information carrying means is a marker.
5. A system according to any preceding claim, wherein the information carrying means emits at least one type of radiation, the at least one type of radiation being selected from the group comprising: visible spectrum light, ultra violet light, infra-red light, magnetic, electromagnetic, micro-wave, radio wave, and sound.
6. A system as claimed in any of Claims 3 to 5, wherein the code comprises at least one line or at least one bar.
7. A system according to any preceding claim, wherein the information carrying means is at least one route marking.
8. A system as claimed in Claim 7, wherein the route marking is a continuous marking or an intermittent marking.

9. A system as claimed in Claim 7 or 8, wherein the route marking extends in the direction of the route or at an angle to the direction of the route.
10. A system as claimed in any of Claims 7 to 9, wherein the system reads the information contained in the or each route marking and the control output is related to the information contained in the said the or each route marking.
11. A system as claimed in any of Claims 7 to 10, wherein the information contained in the route marking depends on the size and/or shape thereof.
12. A system as claimed in any of Claims 7 to 11, wherein the information contained in the route marking depends on the position thereof.
13. A system according to any of Claims 7 to 12, wherein the route marking extends across the full width of at least a part of the route.
14. A system according to any preceding claim, wherein the information carrying means is a bar code.
15. A system as claimed in any of Claims 1 to 14, wherein the information contained in the information carrying means is selected from the group comprising: speed limit, speed, direction, lane deviation, no overtaking, no access area, hazards, location, advertising.
16. A system according to any preceding claim, further comprising alerting means, the said alerting means being recognisable by the controller to alert the said controller to forthcoming presence of information carrying means.
17. A system according to Claim 16, wherein the alerting means includes a code.
18. A system as claimed in Claim 16 or 17, wherein the alerting means comprises a line, bar, light, a magnet, or electromagnetic radiation emitter.
19. A system according to any of Claims 16 to 18, wherein the code includes an indication to the relevance of the information in the information carrying means to the vehicle.
20. A system as claimed in any preceding claim, wherein the control output is selected from the group comprising: speed limit, speed, direction, lane deviation, no overtaking, no access area, hazards, location, advertising.
21. A system as claimed in Claim 20, wherein the control output comprises an input to a vehicle controller.

22. A system as claimed in Claim 21, wherein the vehicle controller compares a vehicle parameter with the input to the vehicle controller, and wherein the vehicle controller issues a vehicle control signal derived from the comparison between said vehicle parameter and said input.
23. A system as claimed in Claim 21, wherein the control output indicates an overspeed, and wherein the vehicle controller includes a speed change means and the speed change means affects a reduction in speed of the vehicle to match said speed to a prevailing speed limit.
24. A system as claimed in any of Claims 21 to 23, wherein the control output indicates a lane deviation, and wherein the vehicle controller includes a direction change means and the direction change means affects a change in direction of the vehicle to correct the said lane deviation.
25. A system as claimed in any preceding claim, wherein the vehicle includes a notification means, and wherein the control output comprises an input to the notification means, and upon receipt of said input information is notified by the said notification means.
26. A system according to Claim 25, wherein the notification means is selected from the group comprising: a display, a loud speaker, a voice synthesiser, one or more lights, and a vibrator.
27. A system according to Claim 26, wherein the notification means notifies the driver of the vehicle.
28. A system according to Claim 26 or 27, wherein the notification means includes a display readable outside the vehicle.
29. A system according to any preceding claim, wherein the detector is a camera.
30. A system according to Claim 29, wherein the camera is a line scanning camera.
31. A system according to Claim 1, wherein the information carrying means comprises an electromagnetic radiation transmitter.
32. A system according to Claim 31, wherein the transmitter is a radio frequency transmitter and the detector is a radio frequency transceiver.
33. A system according to Claim 31 or 32, wherein the detector is movably mounted on the vehicle.

34. A system according to any preceding claim, further comprising data storage means.
35. A system according to Claim 34, wherein data stored in the data storage means is derived from information carried by the information carrying means.
36. A system according to any preceding claim, wherein the route marking is the information carrying means and carries other information relevant to the route and readable by drivers of vehicles on the route.
37. A system according to any preceding claim, wherein the control output signal relates to lane deviation, and wherein the information carrying means carries a information relating to a location of an edge of route or a part of a route, and wherein the detector detects the information carrying means and generates a detector output signal of vehicle position with respect to the edge and the controller generates a control output to correct the position of the vehicle before the vehicle reaches the said edge.
38. A system according to Claim 37, wherein the information carrying means is located inwardly of the route edge.
39. A system according to any preceding claim, wherein the route is a road and the vehicle is a road going vehicle.
40. A system according to any of Claims 1 to 38, wherein the route is a railway track and the vehicle is a rail going vehicle.
41. A system for generating a control output signal substantially as described with reference to, or as shown in, the drawings.
42. A method of generating a control output signal using a system as claimed in any of Claims 1 to 38, comprising the steps of:
 - i) detecting information carried on information carrying means located on a vehicular route;
 - ii) generating a detector output signal carrying at least part of the information carried by the information carrying means;
 - iii) using the detector output signal as an input to the processor;
 - iv) generating a control output.

Fig (1)

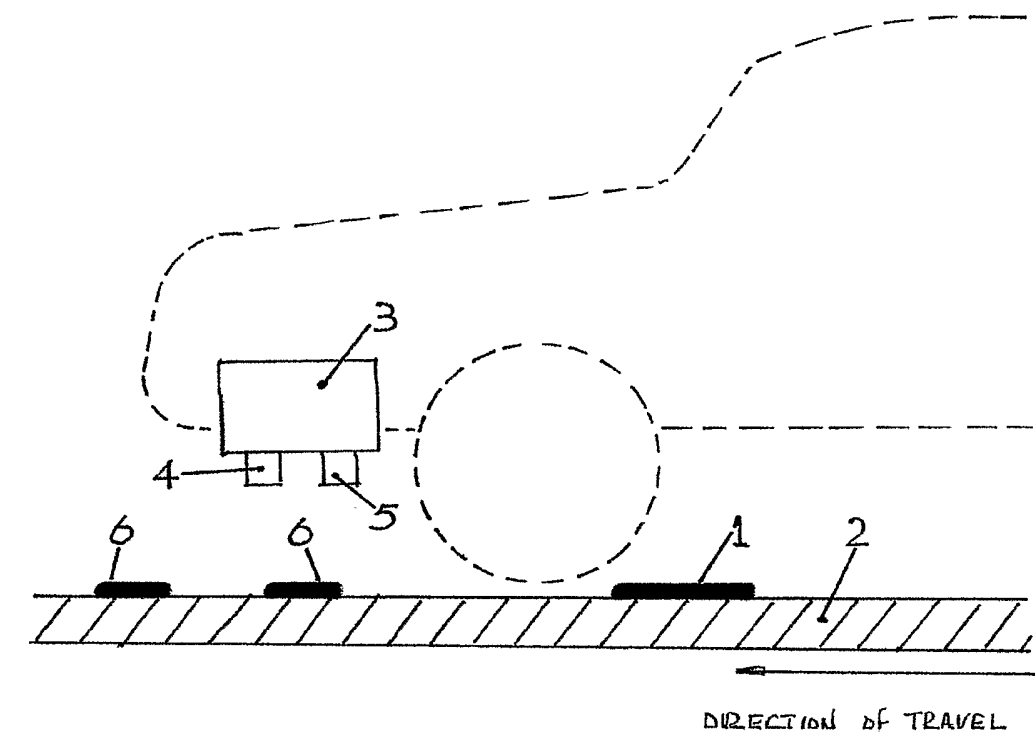
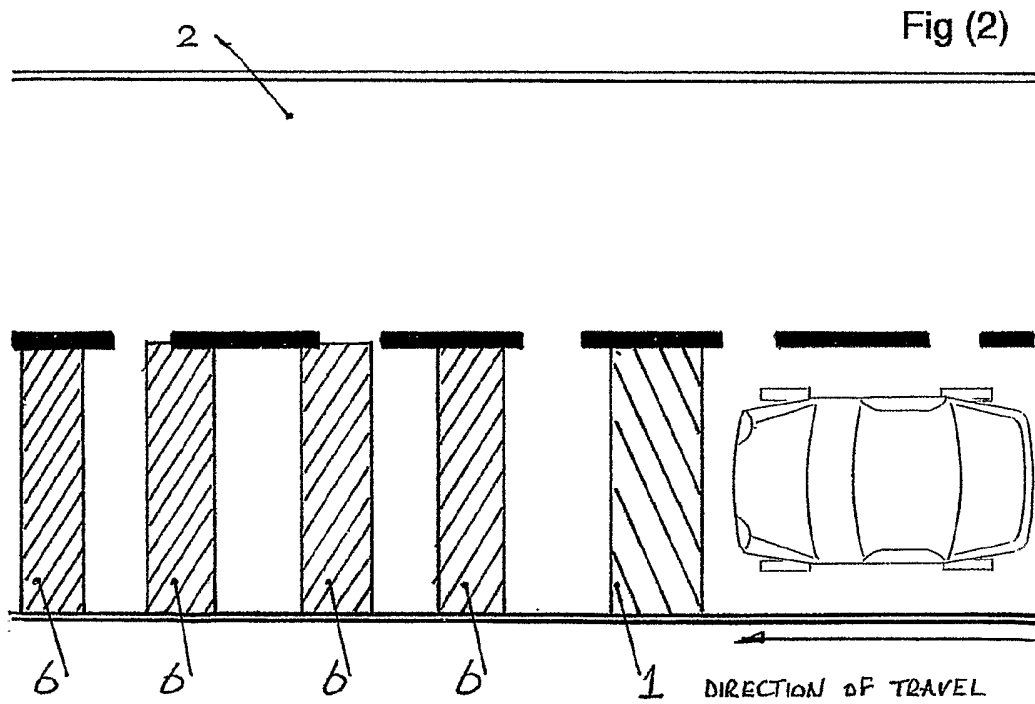


Fig (2)



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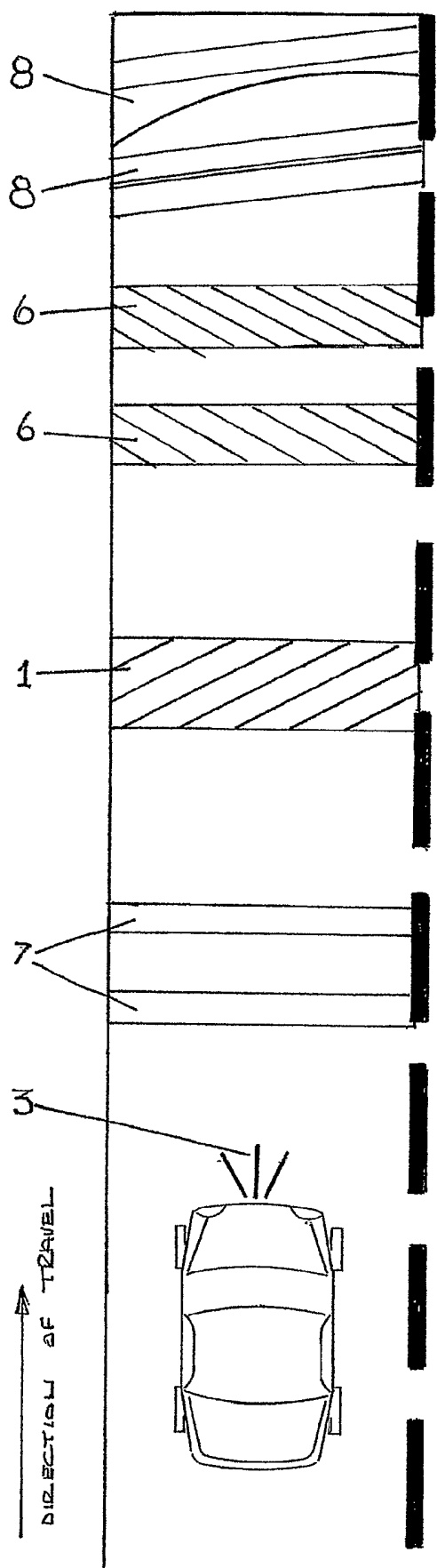


Fig (3)

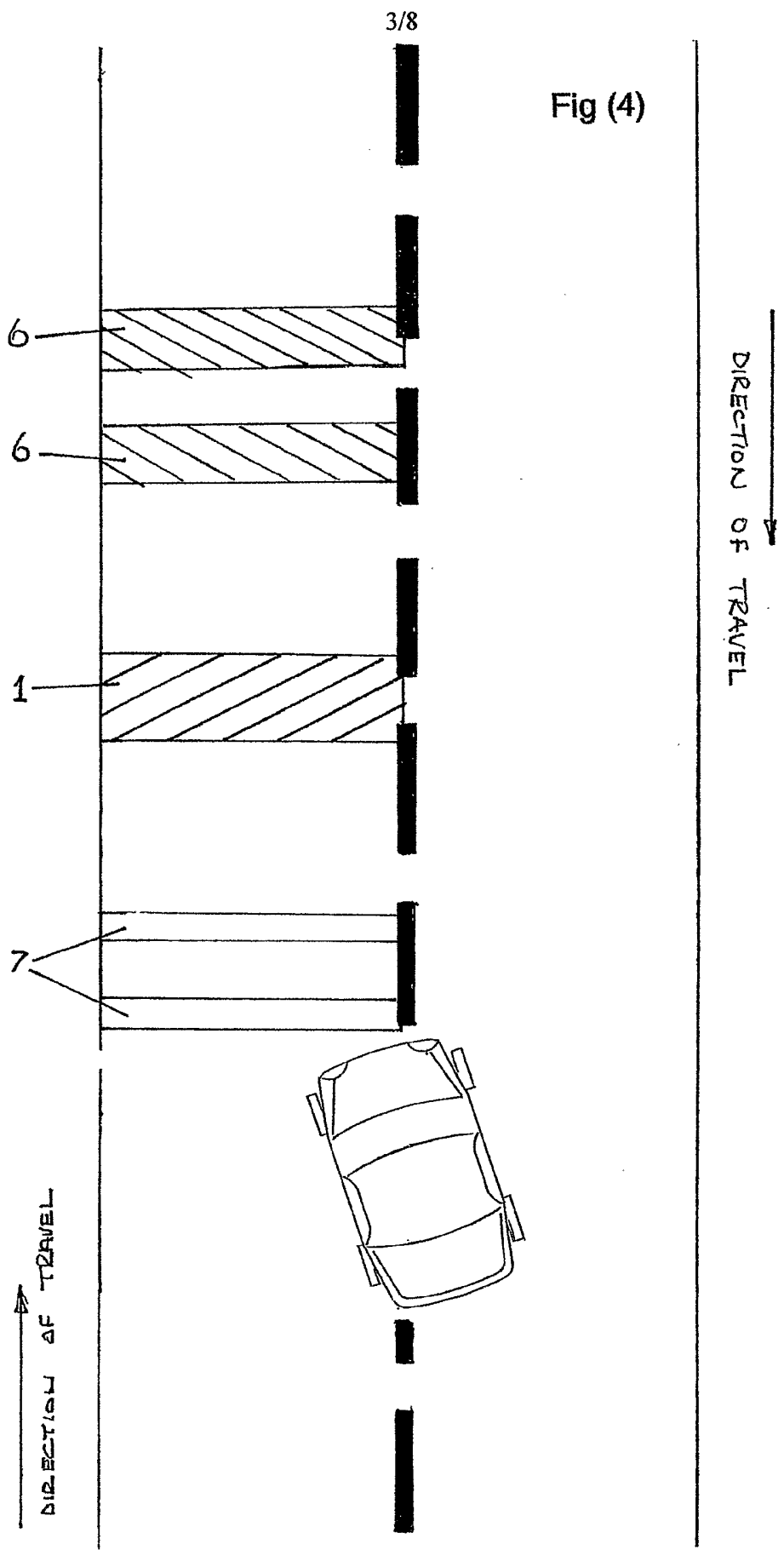


Fig (5)

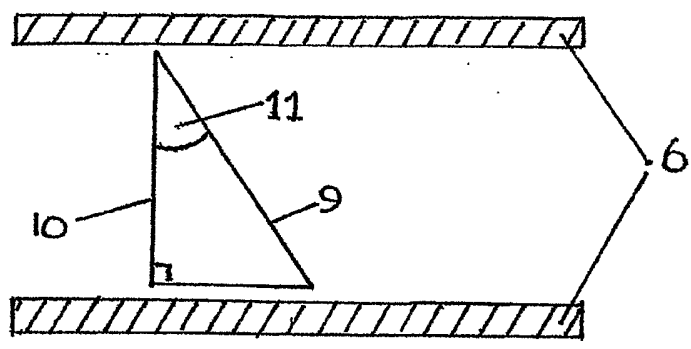
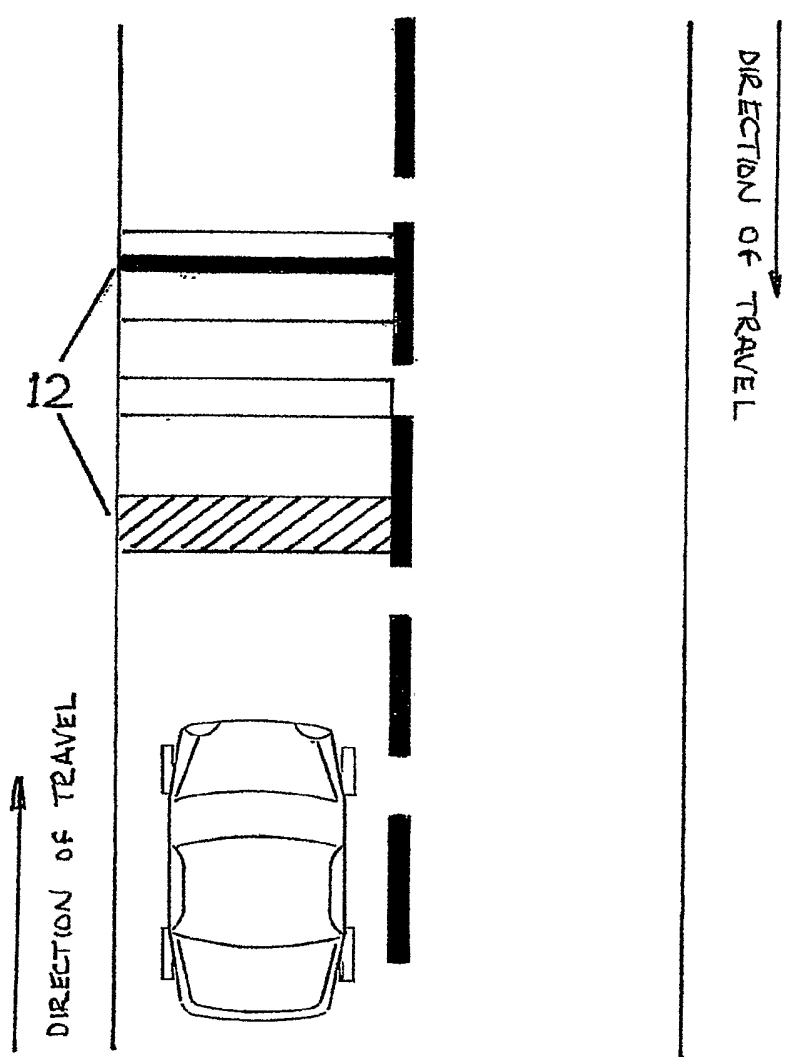


Fig (6)



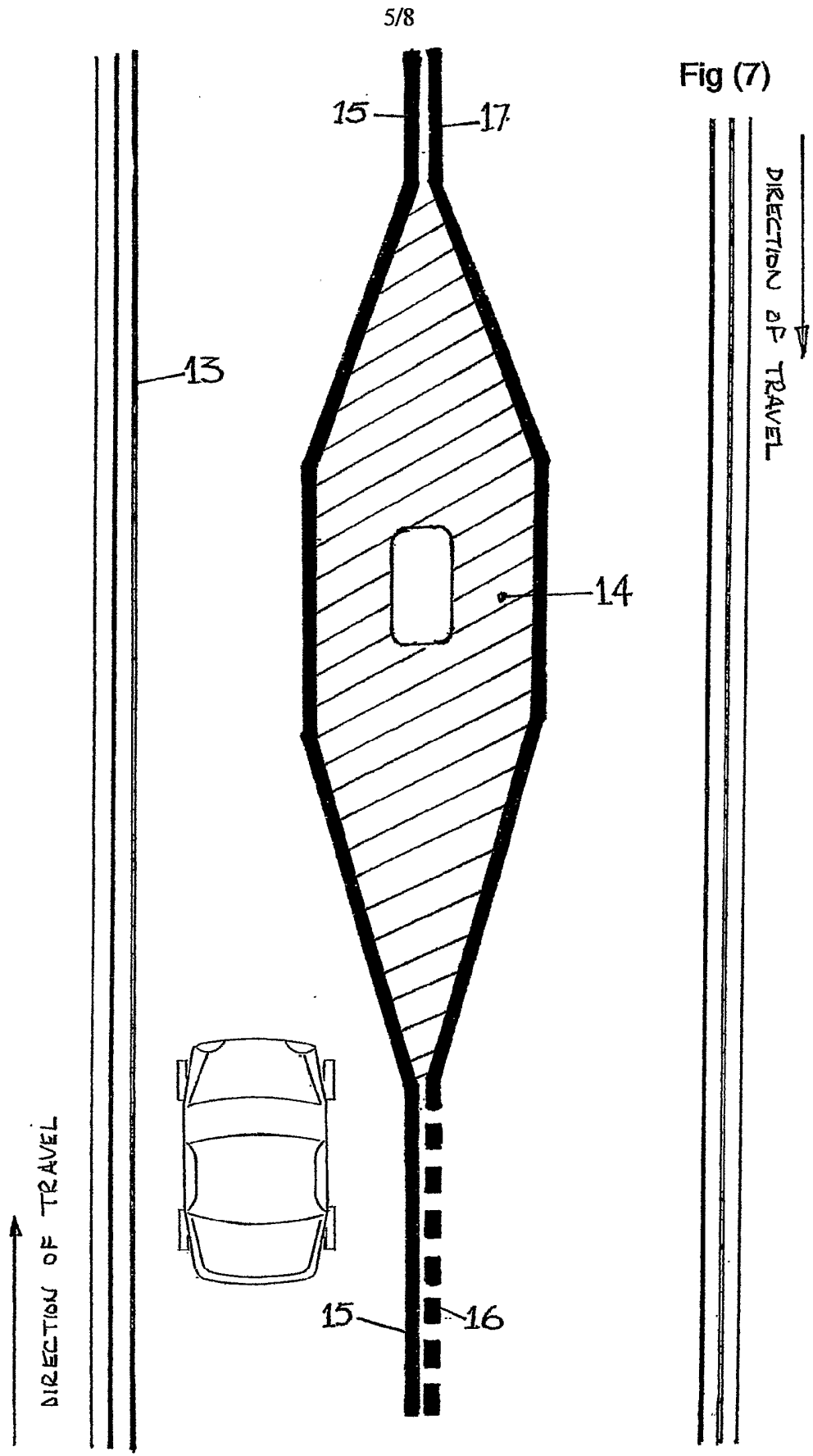
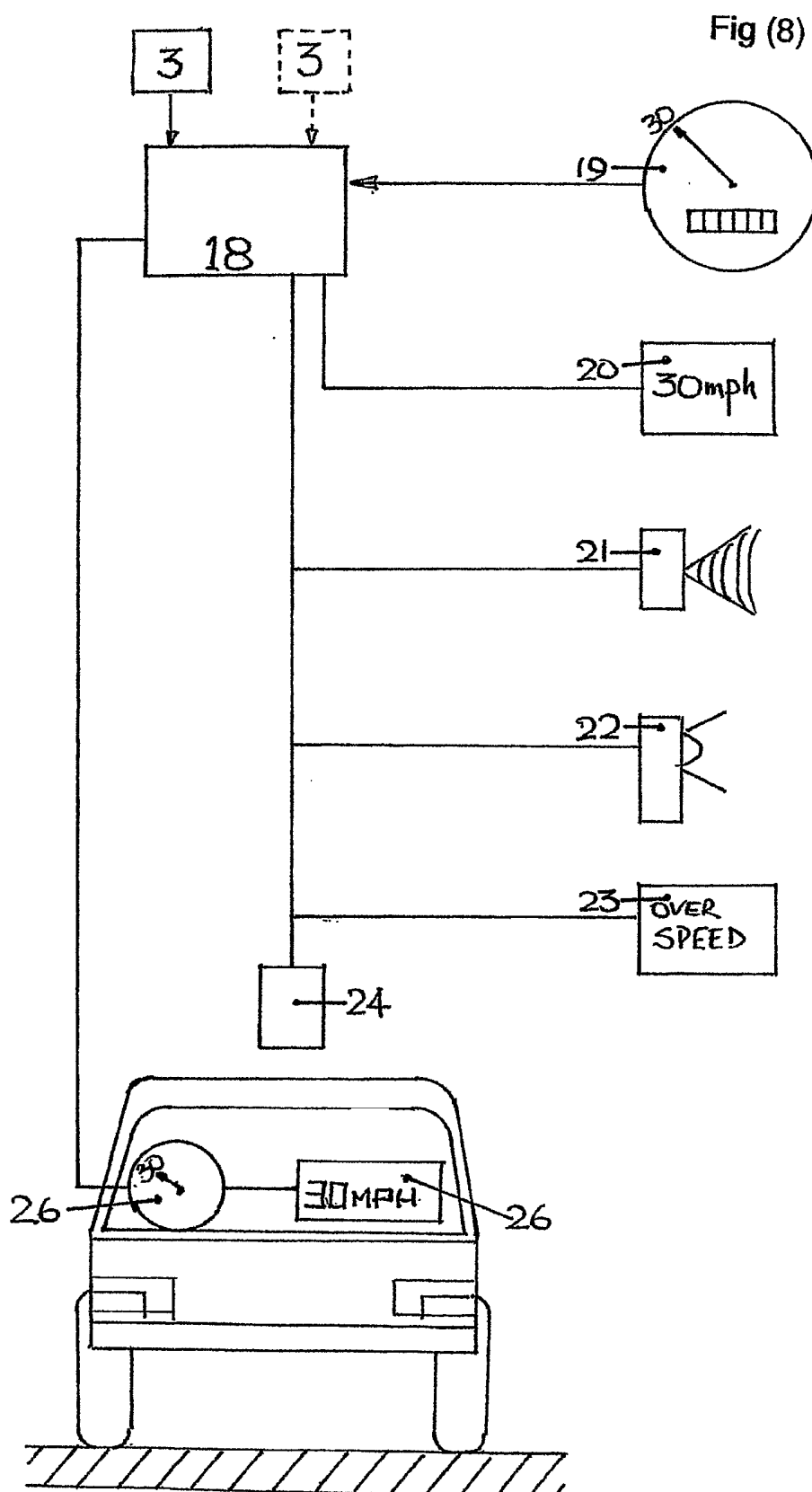
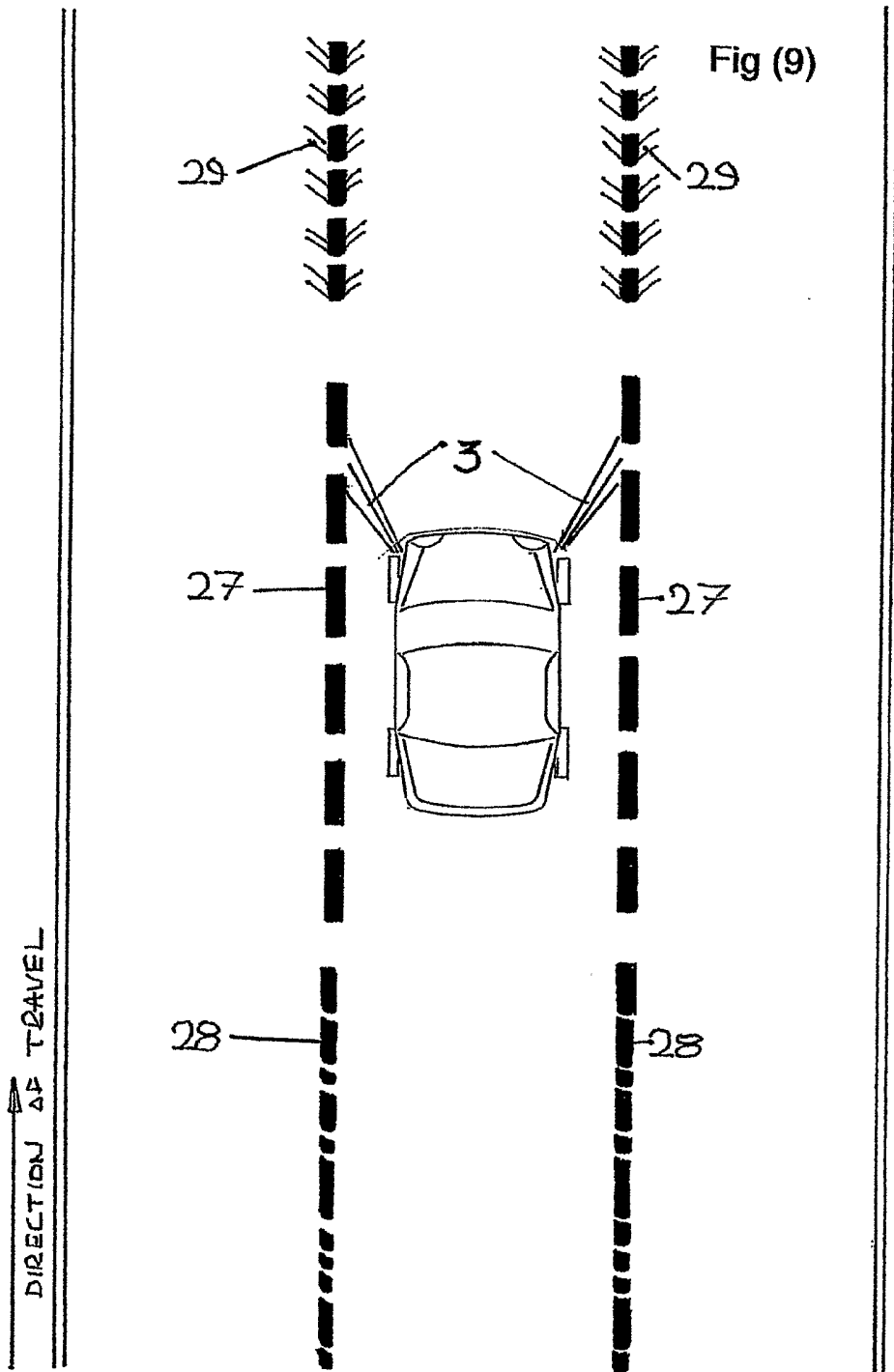
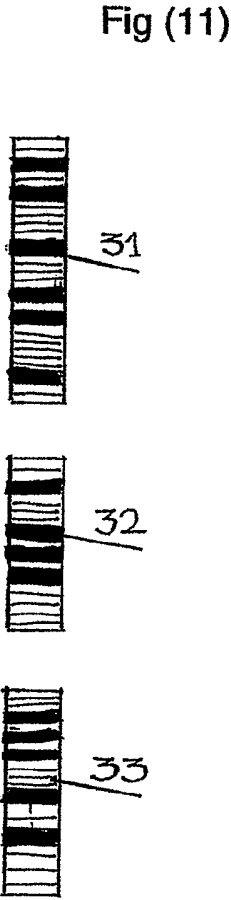
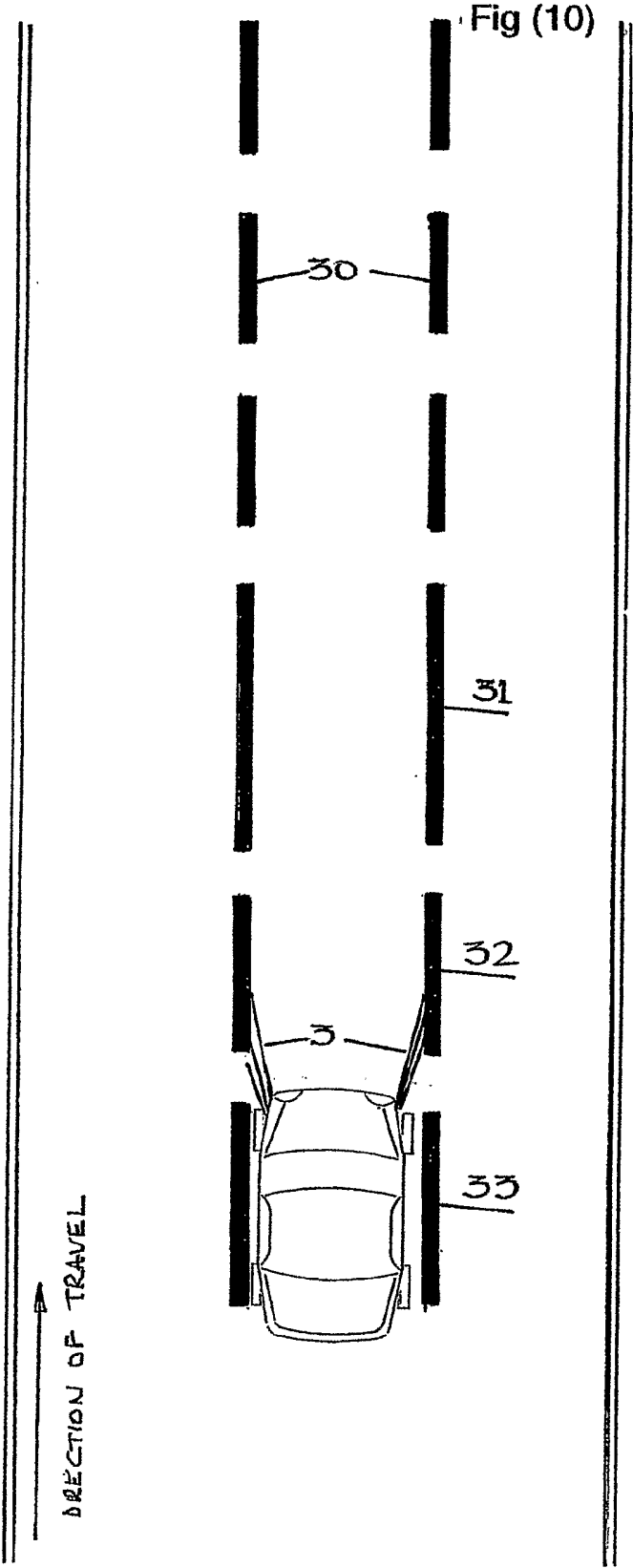


Fig (7)

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB2005/000850

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G08G1/0967 B60K31/00

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)
IPC 7 G08G B60K

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

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 99/60544 A (BALDINOTTI, GRAZIANO) 25 November 1999 (1999-11-25) page 2, lines 12-19 page 3, lines 14-18 page 4, lines 10-15 page 6, lines 7-17 page 7, columns 7-16 figures 1,5 ----- -/--	1-6, 14, 15, 20-23, 25-29, 34, 35, 39, 41, 42

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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- "A" document defining the general state of the art which is not considered to be of particular relevance
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Date of the actual completion of the international search

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB2005/000850

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 982 278 A (CUVELIER ET AL) 9 November 1999 (1999-11-09) column 1, lines 16-22 column 2, lines 36-56 column 3, lines 12-59 figures 4,5	1,7-13, 20,24, 36-39, 41,42
X	US 6 388 578 B1 (FAGAN DAVID ET AL) 14 May 2002 (2002-05-14) column 4, lines 17-26 column 5, lines 30-35 figure 1	1,7,8, 10, 31-33, 41,42
X	EP 1 209 648 A (DIRECTOR GENERAL OF NATIONAL INSTITUTE FOR LAND AND INFRASTRUCTURE MAN) 29 May 2002 (2002-05-29) column 5, lines 18-29 column 9, lines 42-50 figure 11	1,16-19, 31-33
X	DE 199 49 699 A1 (ALCATEL, PARIS) 19 April 2001 (2001-04-19) column 1, lines 6-15 column 1, lines 59-67	1,40
X	DE 199 38 256 A1 (VOLKSWAGEN AG) 15 February 2001 (2001-02-15) column 4, lines 17-43	1,25-30

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/GB2005/000850

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
WO 9960544	A	25-11-1999	IT PI980039 A3 AU 3533799 A EP 1078345 A1 WO 9960544 A1	19-11-1999 06-12-1999 28-02-2001 25-11-1999
US 5982278	A	09-11-1999	BE 1009723 A6 BE 1010581 A7 AT 184414 T WO 9717686 A1 DE 69604196 D1 DE 69604196 T2 EP 0860001 A1 ES 2140138 T3	01-07-1997 06-10-1998 15-09-1999 15-05-1997 14-10-1999 27-01-2000 26-08-1998 16-02-2000
US 6388578	B1	14-05-2002	AT 218732 T AU 761560 B2 AU 1171599 A CA 2310786 A1 DE 69805839 D1 DE 69805839 T2 DK 1032929 T3 EP 1032929 A1 ES 2178278 T3 IE 980954 A2 IE 980955 A1 WO 9926213 A1 NZ 504810 A PT 1032929 T	15-06-2002 05-06-2003 07-06-1999 27-05-1999 11-07-2002 20-02-2003 14-10-2002 06-09-2000 16-12-2002 19-05-1999 19-05-1999 27-05-1999 31-01-2003 29-11-2002
EP 1209648	A	29-05-2002	JP 3496055 B2 JP 2002163768 A JP 2002269684 A EP 1209648 A2 US 2002065600 A1	09-02-2004 07-06-2002 20-09-2002 29-05-2002 30-05-2002
DE 19949699	A1	19-04-2001	CH 694650 A5	13-05-2005
DE 19938256	A1	15-02-2001	NONE	