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(54) **Automatic instrumental acquisition of road information on board of a vehicle by passive means deployed on the road surface**

(57) Information relative to speed limit and/or other traffic warning or notice pertaining to the stretch of road the vehicle travelling on, may be automatically acquired by an on-board system of a vehicle designed for receiving, processing, storing and recording data, without requiring the deployment of expensive and delicate transmitters along the roads of a territory. Necessarily updated information may be acquired by the on-board system through durable and low cost passive means by:

establishing a digital coding of the information that must be acquired by said on-board system;

installing on said vehicle and coupling to said on-board system at least a transducer of dynamic solicitations impressed to the vehicle through its suspensions;

laying transversally on the surfacing of the carriageway or on the lanes of a certain direction a plurality of parallel crests spaced from one another such to reproduce a binary code corresponding to said information;

processing the signal generated by said transducer for recognizing said binary code corresponding to the pattern of relative distribution and spacing of said parallel crests;

generating depending on the so acquired information an alertment or warning to the driver and/or storing the information in a memory buffer of the system.

On a driving license in the form of an electronic smart card, necessarily inserted into a card reader/writer peripheral of the on-board system may be nonvolatily recorded an eventual infraction and fine according to regulamentary algorithm of pre-warnings issued to the driver.

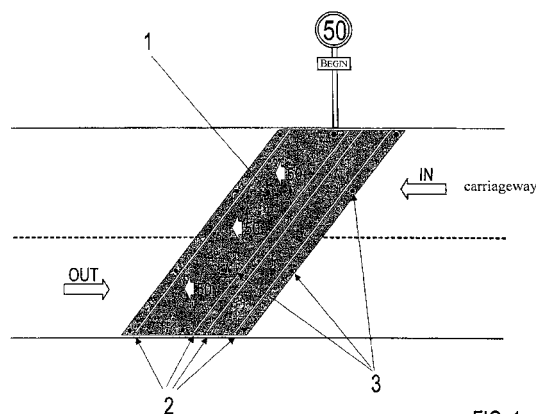


FIG. 1

Description

[0001] The present invention relates in general to automatic data acquisition by a system for detecting, acquiring, elaborating and recording data installed on-board of a travelling vehicle. More particularly the invention relates to systems supporting instrumental use of driving licenses in the form of electronic cards, that may be inserted in a suitable card reader coupled to the system present on-board of a vehicle and on which data such as fines or other sanctions may eventually be invariably recorded.

BACKGROUND OF THE INVENTION

[0002] It is generally accepted that in order to stop and possibly invert the trend of an apparently unrestrained up-trend of tragic statistics of car accidents it is imperative to promote a general cultural change based on a punctual tutoring toward more responsible and prudent behaviors, especially for the new generations of drivers, coupled with some sanctionary mechanisms that be effective in discouraging illicit and dangerous behaviors of drivers.

[0003] More than fines, it has become more and more evident that the risk of suspension and/or revocation of the driving license is a most effective deterrent, because of the risk of being inhibited from driving for more or less long periods, during which a recidivist driver could suffer highly penalizing consequences: from a conditioned ability to work to the somewhat limited freedom of movements.

[0004] These mechanisms may contemplate, in case of illicit behavior, even the revocation of the license, following which the no longer licensed driver must necessarily sustain and pass anew an examination to obtain a new driving license.

[0005] These sanctionary mechanisms, at present being under parliamentary debate, are based on the concept of the so-called "mark license", that is a special driving license endowed with a certain credit of marks upon issuance, a credit that is progressively decremented whenever certain infractions relating to particularly dangerous behaviors are committed by the driver. Should the credit of marks be completely exhausted, the driving license is automatically suspended for a certain period of time or, in certain circumstances, is revoked.

[0006] Sanctionary schemes based on a "credit mark patent" imply or would greatly benefit from the introduction of a driving license in the form of a magnetic card or more effectively of a so-called smart card, the stored data on which could be read by inserting the card in a suitable card reader (for example by road patrols and police officers). Eventual infractions and fines as well as a temporary suspension of the driving license for a certain time could be easily recorded in a nonvolatile and unviolable manner on the card, as far as revoking it by making the electronic driving license card void.

[0007] It is evident that, besides the best intention and a recognizable effectiveness of such a sanctioning system based on the patent with an endowing of consumable credit marks, it is equally recognizable that most of the recalcitrant infringers will simply continue to "bet their luck" on the relatively small probability of being caught, especially at night and/or on scarcely patrolled roads.

[0008] It has been proposed, according to a far more effective approach, to create a real deterrent to illicit driving of imposing the insertion of a valid electronic patent in a card reader/writer device peripheral of an on-board system of any vehicle, to enable the starting and running of the engine. That is the use of the electronic patent as a "personal" ignition key of the vehicle.

[0009] It has also been proposed to eventually record sanctions on the electronic driving license inserted in the card read-write device in a fully automatic way. This would happen, for instance, when the vehicle continues to be driven at a speed in excess of a certain maximum speed for a certain time after a first and eventually a repeated alerting acoustic or optical signal has been issued by the on-board system interfaced with the card read/write peripheral device.

[0010] Even an effective though expensive data transmission system based on the use of fixed radio beacons irradiating a relatively short range radio signal representative of the speed limit that is enforced on the road traveled by the vehicle has been proposed. Such a radio signal would be automatically picked by a suitable on-board receiver interfaced with the on-board system for updating automatically the stored speed limit to the one valid on the stretch of road being traveled by the vehicle. The enforced speed limit would be continuously compared with the instantaneous speed of the vehicle suitably monitored by the system for producing a first acoustic or optical signal warning the driver that he is overcoming the speed limit. Should the driver not reduce its speed below the speed limit, after a brief interval a second warning signal would be issued for informing the driver that a sanction would soon be recorded on its electronic driving license. Should the driver fail to reduce the speed even after this second alertment, the infraction will be definitively recorded in a nonvolatile memory buffer of the electronic driving license.

[0011] It is clear that, besides the effectiveness of the system disclosed in the prior Italian patent application No. VA2000A000013, in the name of the same applicants, the installation of such fixed radio transmitters along every roads or at least along a large number of roads of a certain territory would be relatively expensive both in terms of the initial investment as well as of the maintenance that such delicate electronic devices will require. Moreover, each of these radio devices will require means for powering them preferably in the form of a photovoltaic panel and associated buffer batteries.

[0012] Another drawback of such a system is the impact on the environment, because the dissemination of

the territory of radio transmitters would increase sensibly the level of electromagnetic pollution.

OBJECT AND SUMMARY OF THE INVENTION

[0013] It has now been found and is the object of the present invention a method and a relative system for automatically acquiring information relating to the speed limit being enforced on the road being traveled by a vehicle and/or other information concerning road signs and/or notices to drivers by an on-board system that, differently from the solution proposed in the above mentioned prior patent application, require the deployment in the territory of essentially passive and low cost means.

[0014] Essentially, the method of the invention consists in establishing a digital coding of the information to be acquired by the on-board system of a vehicle, providing such an on-board system with at least a dynamic sensor, such as for example an accelerometer, a pressure sensor of the fluid of at least a shock absorber of the suspensions of the vehicle, an acoustic sensor or equivalent capable of detecting vibrations or similar solicitations of the vehicle or more preferably of its suspensions, and in laying across the carriageway or the lanes of a certain direction, a number of parallel crests or ridges spaced from one another according to a scheme reproducing a binary code corresponding to a certain information that must be acquired by the on-board system, according to said pre-established coding.

[0015] Such a dynamic sensor installed on the vehicle is ordinarily coupled to an analog and/or digital filtering circuit and to detecting circuits for generating corresponding logic signals that may be processed by the system. The system monitors the binary pattern of the transversal crests or ridges from the time-base pattern of vibrations provoked on the vehicle when the wheel pass over them and when eventually recognizes a significative sequence acquires the corresponding information.

[0016] The system processes the so acquired datum and may issue an alertment signal to the driver and/or store the acquired datum in a RAM buffer of the system.

[0017] In case the information automatically acquired by the on-board system of the vehicle simply by passing over the coded pattern of transversal crests, corresponds to a speed limit being enforced on the stretch of road, the system updates the value with which the actual speed of the vehicle must be compared. Should the speed exceeds the speed limit in force on the road, the system warns the driver that its speed is excessive for example by an acoustic and/or an optical signal.

[0018] The system may also, at the same time, start a timer. When the pre-established time has elapsed, the system may generate a second acoustic or optical signal for warning the driver that, should the speed not be reduced, the system will, after a second pre-established time has elapsed from the issuance of the warning,

record in a permanent and inviolable way, the occurred infraction of the speed limit on the electronic driving license that is inside the card read/write device.

[0019] The shape of the parallel crests or ridges spaced according to the adopted digital coding, may be of any suitable type. The crests may be made of any wear and with resistant material capable of withstanding the stresses caused by the traffic passing on them.

[0020] Preferably and in a particular effective and convenient way, for any encoded datum or information that must be acquired by the on-board system of vehicles, a continuous ribbon of artificial rubber or of any other extrudible plastic material may be produced. A number of parallel and properly spaced crests, provide a binary code corresponding to the information or spread limit value according to the adopted binary encoding.

[0021] Segments of extruded ribbon long as the width of the carriageway or of the lanes, may be cut from a continuous ribbon that can be fabricated in rolls of great length.

[0022] The piece of ribbon set transversally on the carriageway may be secured with nails or equivalent fasteners and/or glued onto the asphalt coat of the carriageway.

[0023] The ribbon so set across the carriageway constitutes the passive means for relaying the information to the dynamic detection system installed on vehicles passing over the coded sequence of crests realized on the upper face of the extruded ribbon.

[0024] The particular information that is digitally encoded on the extruded ribbon and the necessary indications for laying it across the road may be permanently printed on each ribbon in natural language or with appropriate symbols. For instance, arrows indicating the direction whit which the vehicles must pass over the encoded profile may be printed on the ribbon, making it suitable to the handled and laid even by unqualified.

[0025] The device for acquiring the information that is dynamically transmitted by the passive means to the on-board system on the vehicle, may be realized with analog and/or digital circuits and devices. The latter embodiment is preferable because of the intrinsic compatibility of digital circuits with modem processing, storing and data recording techniques.

[0026] The dynamic transducer, for instance a commercial accelerometer, may provide another analog output signal or a digital signal, for example a PWM signal.

[0027] Even if transducers such as accelerometers, pressure sensors or equivalent dynamic transducers generate an analog signal, the signal may be suitably filtered and converted in a digital signal according to common techniques that are similar, under certain aspects, to the techniques used for the read channels of mass data storage devices employing magnetic pickups.

[0028] Naturally the clock signal used to "read" the digital signal obtained by the dynamic sensor, after fil-

tering and analog/digital conversion, will have a frequency that is strictly correlated (directly proportional) to the instantaneous speed of the vehicle. In this way the clock will always provide a correct time based for discriminating the information content of the sequence of peaks (for example corresponding to logic high or "ones" alternated with valleys corresponding to a logic low or "zeroes"), irrespectively from the speed with which the vehicle wheels roll over the encoded pattern of parallel crests disposed transversally to the carriageway.

[0029] Such techniques and relative implementing logic circuitry are commonly used and are well known to any skilled designer of digital circuits.

[0030] The binary encoding of the information to be automatically acquired by the system installed in the vehicle upon passing over the encoded sequence of crests and troughs, may be of any type capable of allowing an easy discrimination of the information.

[0031] For example the encoding system may be based on a single byte of information constituted by eight bits. In this case, the encoded carpet or ribbon laid on the road surface may have a maximum number of eight parallel crests equally spaced among them by a certain "guard" distance, representing a byte constituted by eight bits all equal to a logic "one".

[0032] Information may be encoded using in the most appropriate manner the available bits. For instance, information may be encoded using a certain number or core of "inner" bits, that is a certain pattern of the inner crests while reserving at least the two extreme bit locations for discriminating (elimination) an eventual indetermination.

[0033] Even reserving the two "outer" bits or even more bits to solve cases of possible indetermination (as exemplified hereinbelow), the amount of information that may be encoded using the rest of the bits is considerable.

[0034] For example, if a certain information relating to the speed limit at a certain point along a road at the boundary of a built in area, that coincides with the point past which the urban speed limit is no longer enforced for vehicles coming in the opposite direction, must be acquired by the dynamic pick up system of the vehicle, the ribbon encoding the value of the speed limit inside the urban area may be placed transversally on the whole carriageway that is across all lanes of both directions.

[0035] In this case, the one or two "outer" bits that are first read in the time base by the system of a vehicle entering the zone with a urban speed limit, i.e. the first bit of a successive sequence of bits containing the encoded value of the speed limit, makes the system update and record the new speed limit. On the contrary, the system of a vehicle travelling in the opposite direction onto the same ribbon containing the information of the speed limit, will read the same bit as the least significant bit of the sequence. In practice, the system will read the sequence of bits in the opposite order that is

the reciprocal of the code that is read between entering the urban area and will update the speed limit in force accordingly, for example reistating the same speed limit that was entered the area with such a urban speed limit.

[0036] Of course, other suitable ways of binary encoding may be implemented to solve the same exemplified situation.

[0037] In practice, the same encoded ribbon placed transversally the whole carriageway may mark the beginning of a zone with a certain speed limit, if crossed in a certain direction, or the end of such a zone if crossed in the opposite direction. This arrangement practically vanifies any attempt of dodging the ribbon (should the traffic permits it) to prevent the on-board system from acquiring the urban speed limit, particularly in the case of a state or provincial road with an undivided carriageway.

[0038] The sequence of dynamic pulses is impressed onto the vehicle at least twice consecutively, when the front wheels and the back wheels roll over the crests. The system may even exploit such a repetition for encoding the information to be read or for implementing redundancy or double check techniques for making negligible the probability of false readings.

[0039] An advantageous characteristic of the system of the invention is that it is suitable to implement redundancies when it is necessary or useful that an information (for instance an urban speed limit) be read in a substantially failproof manner by vehicles travelling through a certain area. The sequence of encoded profiles may be placed onto the lanes of an urban road even in a repetitive manner, especially on approaching schools, kindergartens and alike sites.

BRIEF DESCRIPTION OF THE DRAWINGS

[0040] The different aspect and advantages of the system of the invention will become even more evident through the following description of several embodiments and by referring to the attached drawings, wherein:

Figure 1 is a sketch of a road equipped with passive means for relaying information relating to the speed limit to passing by vehicles;

Figure 2 is a sectional view of the passive mean used for transferring the coded value of the speed limit to the on-board system, the corresponding logic signal extracted from the signal generated by the dynamic transducer and the relative binary datum read by the on-board system of a vehicle upon passing over the ribbon with encoded crests in both direction;

Figure 3 is a diagram of the system installed in the vehicle for acquiring, processing and recording data.

DESCRIPTION OF SEVERAL EMBODIMENTS OF THE INVENTION

[0041] Purely for illustration purposes, Fig. 1 depicts a possible embodiment of the passive means of this invention for transferring information to a system installed on a travelling road vehicle.

[0042] In the example considered in Fig. 1 the passive means 1 contain the encoded information of the speed limit being enforced upon entering the urban zone while travelling a two single lane road, not separated by any traffic divider.

[0043] The passive means 1 for transmitting the information of the speed limit may conveniently be placed transversally across the entire carriageway.

[0044] In other words, a carpet or extruded rubber ribbon 1 with the same coded crests is transversally laid and fixed onto the road surfacing as shown in Fig. 1, (for example one at the beginning and another at the end of the built in area obviously installed in opposite orientations on the carriageway congruently with the direction of entering and of exiting the area).

[0045] The carpet 1 may be produced by extruding a synthetic material resistant to wear and tear and weather-resistant. For instance, a suitable material for fabricating a continuous ribbon may be a high wear resistance artificial rubber, such as the one used for soles of shoes or boots, for example the product known as Vibram® produced by the homonymous Italian company.

[0046] Conveniently, the encoded information and the correct orientation of laying onto a carriageway may be printed during the fabrication of the encoded carpet, as shown by the arrow and the number 50 printed at regular intervals in a flat e zone of the carpet of Fig. 1.

[0047] The crests 2 may be several millimeters large and several millimeter tall, from the planes face of the carpet.

[0048] Modern accelerometers or sensors of pressure of the fluid of at least a shock absorber of the suspensions of a vehicle, and even other types of functionally equivalent dynamic sensors have a sensitivity for perfectly reading the code pattern of the sequence of dynamic pulses or vibrations that are pattern impressed onto a vehicle when its wheels roll over the carpet with encoded crests even if such crests are just few millimeters tall, for example in a relatively low range of 2 and 5 millimeters.

[0049] Depending on the adopted binary encoding, the crests that encode the information to be acquired, processed, read and eventually stored by the on-board system of the vehicle are present or missing in precisely pre-established positions. Each bit location is spaced from another adjacent bit location by a certain "guard" distance, whose constant value may be of one or more centimeters, that is preferably of an order of magnitude greater than the width (dimensions) of the crests themselves.

[0050] A sufficiently ample interval or guard "dis-

stance" facilitates recognition of the pattern of dynamic pulses (on a time scale corresponding to the speed of the vehicle) encoding the information to be dynamically read by the accelerometer or by the pressure sensor or by any other equivalent dynamic sensor installed on-board of the vehicle, either upstream or downstream of the suspensions of the vehicle.

[0051] Installing the transducer "upstream" the shock-absorber of the vehicles makes the transducer sense acceleration peaks that are impressed by the crests undampened by the suspensions but may require a more sophisticated filtering of the analog signal.

[0052] The predetermined spacing of the bits, that is the spacing of the pre-established positions that may be occupied or not by a seam or relief, according to the binary code used for the information to be acquired, is functional to the establishment of a time base for reading the encoded data, independently from the speed of the vehicle passing over the carpet with the coded ridges.

[0053] In fact, the system installed in the vehicle generates a read clock that varies its frequency in function of the instantaneous speed of the vehicle, thus providing for the necessary time base for reading and discriminating the automatically acquired data independently from the speed with which the vehicle passes over the passive means.

[0054] The carpet with encoded crests 1 may be fixed firmly on the surfacing of the carriageway by adhesives and/or by a plurality of nails 3, bolts, brackets or any other functionally equivalent fastener.

[0055] In the depicted example, the carpet with encoded crests of the invention 1 is fixed across the whole carriageway and thus is crossed by traffic in both directions. Of course, this is not an essential or common condition because the encoded carpet may be ordinarily placed transversally only on the lanes in a certain direction of traffic, for example on a divided carriageway and be significantly readable only when crossed in the intended direction.

[0056] The physical profile of the carpet 1 of the example of Fig. 1, is depicted in Fig. 2.

[0057] In the depicted example, a binary encoding based on bytes of eight bits is used, but any other type of coding may be employed.

[0058] According to such a binary encoding, the logic signal that is extracted from the signal output by the dynamic sensor for example through a common peak detecting circuit followed by an analog/digital converter is also shown in Fig. 2.

[0059] The unshaded bands identify, in respect to the physical profile of the carpet 1 with encoded crests 2, the position of each bit (in the depicted example there are eight bits) on a time base, constituting the byte of information.

[0060] For the particular case depicted in Fig. 1, the data that may be read by the dynamic automatic detection system installed in a vehicle are depicted in Fig. 2. In fact, the vehicle may pass over the coded pattern of

crests in the direction of the arrow IN of the Fig. 1, that is it may be entering the area in which the speed limit of 50 Km/h is in force or it may pass over it travelling in the direction of the arrow OUT of Fig. 1, that is it may be leaving the urban area. In each case the dynamic detection system installed in the vehicle will read a respective digital datum, as indicated in Fig. 2.

[0061] The system installed on the vehicle, a functional basic diagram of which is depicted in Fig. 3, reads the new value of the speed limit in force in the urban area upon entering it thus passing over the encoded carpet in the direction of the arrow IN of Fig. 1. Consequently, the system updates the reference speed value with which the instantaneous speed of the vehicle, provided by common speed measuring devices of the vehicle, is continuously compared.

[0062] According to a predetermined scheme of time windows of monitoring and analyzing the speed, the system may eventually generate an acoustic and/or optical alerting signal to inform the driver that the current speed is exceeding the speed limit in force.

[0063] At that time, the system may also start a timer counting a certain time interval at the expiration of which the driver is warned acoustically and/or visually of the fact that should he fail to reduce the speed, the system will issue a sanction, recording it in an inviolable manner on the electronic driving license card present in the read/write device.

[0064] Eventually, the issued sanction will be permanently recorded in a nonvolatile memory buffer of the electronic driving license card (that functions also as ignition key of the engine) of the driver.

[0065] Enacted laws accounting for the use of electronic driving licenses on which sanctions may be automatically be recorded according to this invention, may contemplate that the driver be obliged to pay a commensurate fine by a certain deadline date whenever incurring in an automatically issued sanction.

[0066] Road patrol and policemen may at any time check the driving license by inserting it in a read/write device reading and eventually printing the data stored in it. In this way, any unpaid fine would manifest and the officer may fill in an infraction report or take other legally established actions.

[0067] Obviously, the systems installed on-board of vehicles may even be provided with suitable automatic means for transmitting via radio eventual sanctions issued on a certain driving license to a control center that may monitor the timely payment of fines and eventually take the preordered actions.

[0068] A self-sanctioning system according to the present invention may effectively implement in a substantially automatic way even the "limited credit mark licenses". An appropriate algorithm reflecting the criteria established by law implemented by the on-board system (that may be programmed in an inviolable manner in a ROM or a FLASH EPROM buffer, even using encrypting techniques for enhanced security) may automatically

suspend the driving license, if the national laws contemplate such a sanction once plural infractions or traffic regulation of certain kinds are recorded on the electronic driving license during a certain period of time.

[0069] Even in this case, the on-board system of the vehicle may signal the validity status of the electronic patent currently inserted in the read/write device of the system. In this way the driver may be constantly informed of the fact that should he incur in one or more sanctions of a certain kind, as issued in a fully automatic way by system itself, his driving license will be suspended for a pre-established period of time (or even revoked).

[0070] Both in the case of an automatic suspension or revocation of the driving license, the system disable the electronic driving license, preventing it from being used again as ignition key of any engine, as long as the period of suspension has expired, or definitely in case of revocation.

[0071] Alternatively, should the automatic disabling of the driving license be considered too risky for safety reasons (because it could prevent the start of a vehicle even in a dangerous situation), the state of suspension or of revocation would be detectable at any check of the driving license by a road patrol or police officer.

Claims

1. A method of automatically acquiring by an on-board system of a vehicle for receiving, processing, storing and recording data, information relative to speed limit and/or other traffic warning or notices pertaining to the stretch of road the vehicle travelling on through passive means, comprising the steps of
 - establishing a digital coding of the information that must be acquired by said on-board system;
 - installing on said vehicle and coupling to said on-board system at least a transducer of dynamic solicitations impressed to the vehicle through its suspensions;
 - laying transversally on the surfacing of the carriageway or on the lanes of a certain direction a plurality of parallel crests spaced from one another such to reproduce a binary code corresponding to said information;
 - processing the signal generated by said transducer for recognizing said binary code corresponding to the pattern of relative distribution and spacing of said parallel crests;
 - generating depending on the so acquired information an alertment or warning to the driver and/or storing the information in a memory buffer of the system.
2. The method of claim 1, **characterized in that** the stored information is compared with current param-

eters of travelling of the vehicle, eventually establishing a condition of infraction of traffic rules to be signaled to the driver as far as until is eventually issuing a sanction that is recorded in a nonvolatile and inviolable manner of an electronic driving license card that is inserted in a read/write peripheral device of the on-board system enabling the start up and running of the engine.

3. A system for automatically acquiring information relating to the speed limit in force or other traffic warning pertaining to the stretch of road being travelled by the vehicle through passive means, **characterized in that**

said passive means consists of a plurality of parallel crests disposed across the road surface spaced from one another such to reproduce a binary code and corresponding to said information; and the system comprises:

at least a transducer of dynamic solicitations impressed to the vehicle through its suspensions coupled to an on-board signal processing and data acquisition;

circuit means of said on-board system processing the signal generated by said transducer recognizing the dynamic pulses impressed by said transversal seams binary code corresponding to the pattern of relative distribution and spacing of said parallel crests;

means for generating an alertment or warning to the driver and/or storing recording the information in a memory buffer of the system.

4. The system of claim 3, **characterized in that** it comprises

a read/write peripheral device for an electronic driving license card to inserted therein for enabling the start up and running of the engine of the vehicle; said electronic driving license card having a nonvolatile memory buffer on which sanctions automatically issued by the system may be inviolably recorded.

5. The system of claim 4, **characterized in that** it comprises

means for comparing an acquired and stored information with current parameters of travel of the vehicle, establishing eventual infractions that may be signaled to the driver and for eventually issuing a sanction by inviolably recording it in said nonvolatile memory buffer of said electronic driving license card.

6. The system according to claim 5, **characterized in that**

said information is the speed limit being enforced on the stretch road the vehicle is travelling along;

said means comparing the instantaneous speed of the vehicle with said speed limit stored in a memory buffer of the system.

7. The system according to claim 3, **characterized in that** said parallel crests transversally disposed on the surface of the road are in the form of a carpet of a wear and weather resistant material laid transversally onto the road surface or a portion of it and having its upper face said plurality of parallel crests that may be present or missing at pre-established positions uniformly spaced from one another by a fixed guard distance, reproducing the binary code corresponding to a certain digitally encoded information.

8. The system according to claim 3, **characterized in that** it comprises means for generating a read clock of frequency proportional to the instantaneous speed of the vehicle, said circuit means for processing the signal generated by said transducer recognizing the binary code corresponding to the pattern of dynamic pulses impressed to the vehicle by said transversal crests on the time base provided by said read clock.

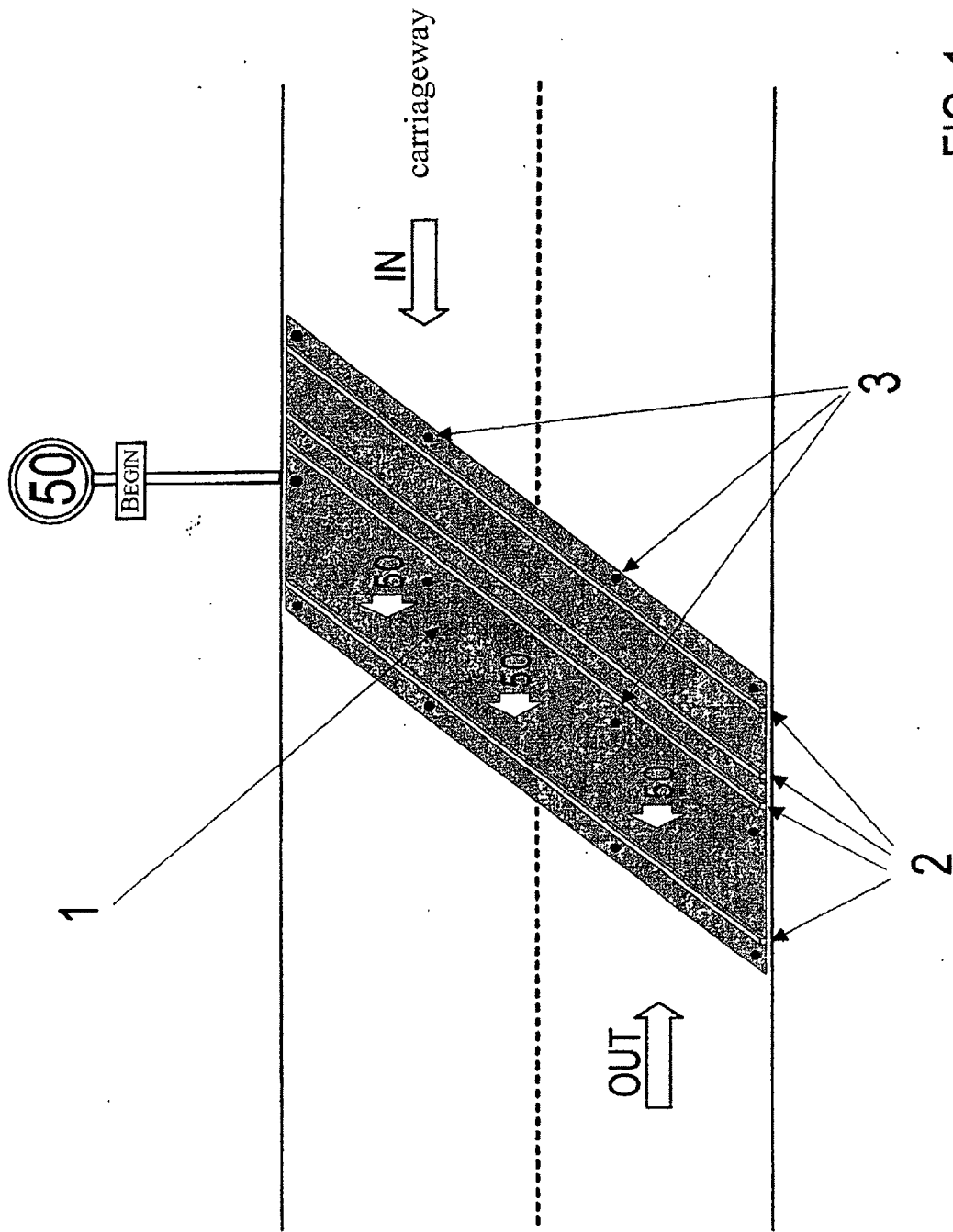


FIG. 1

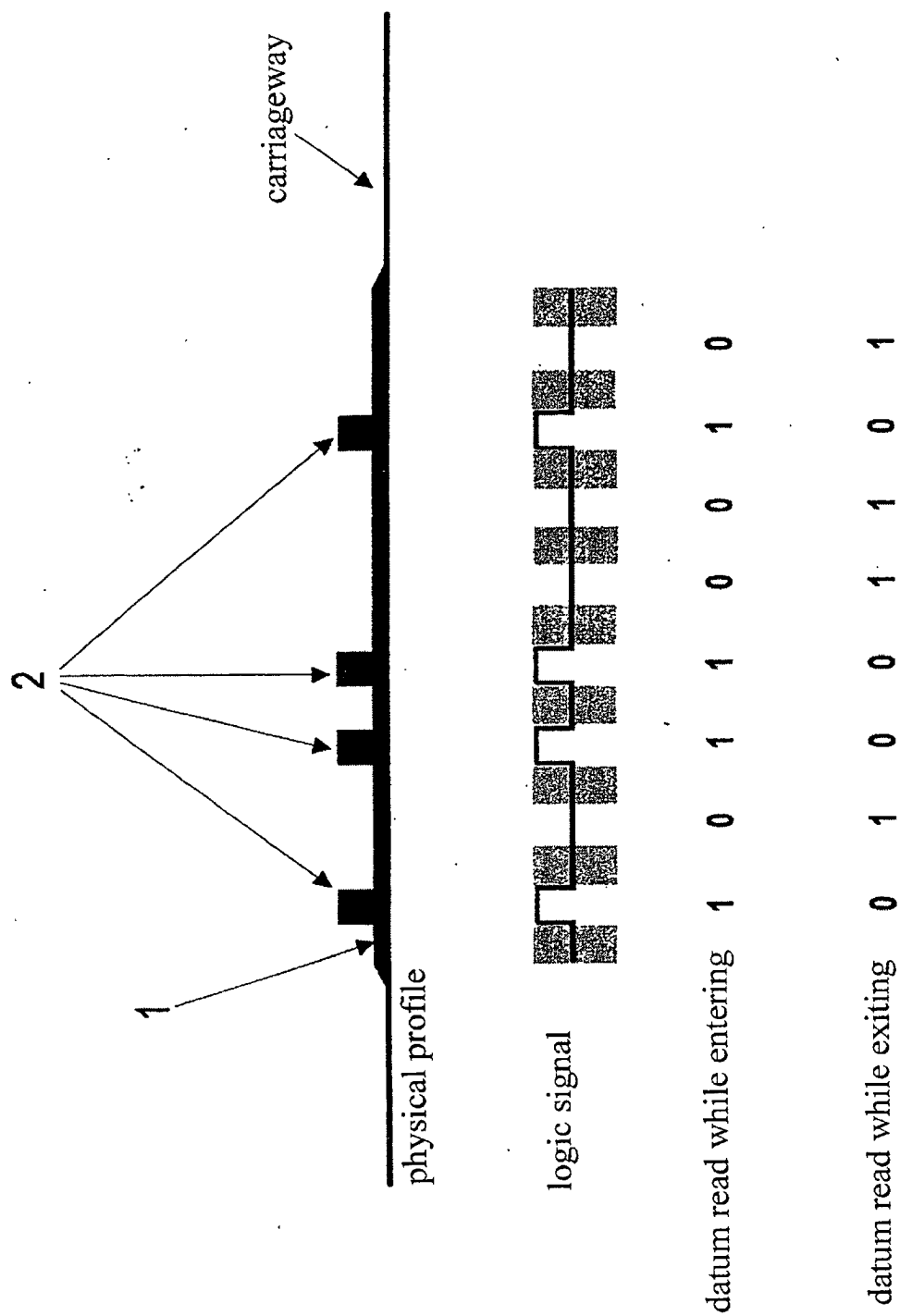


FIG. 2

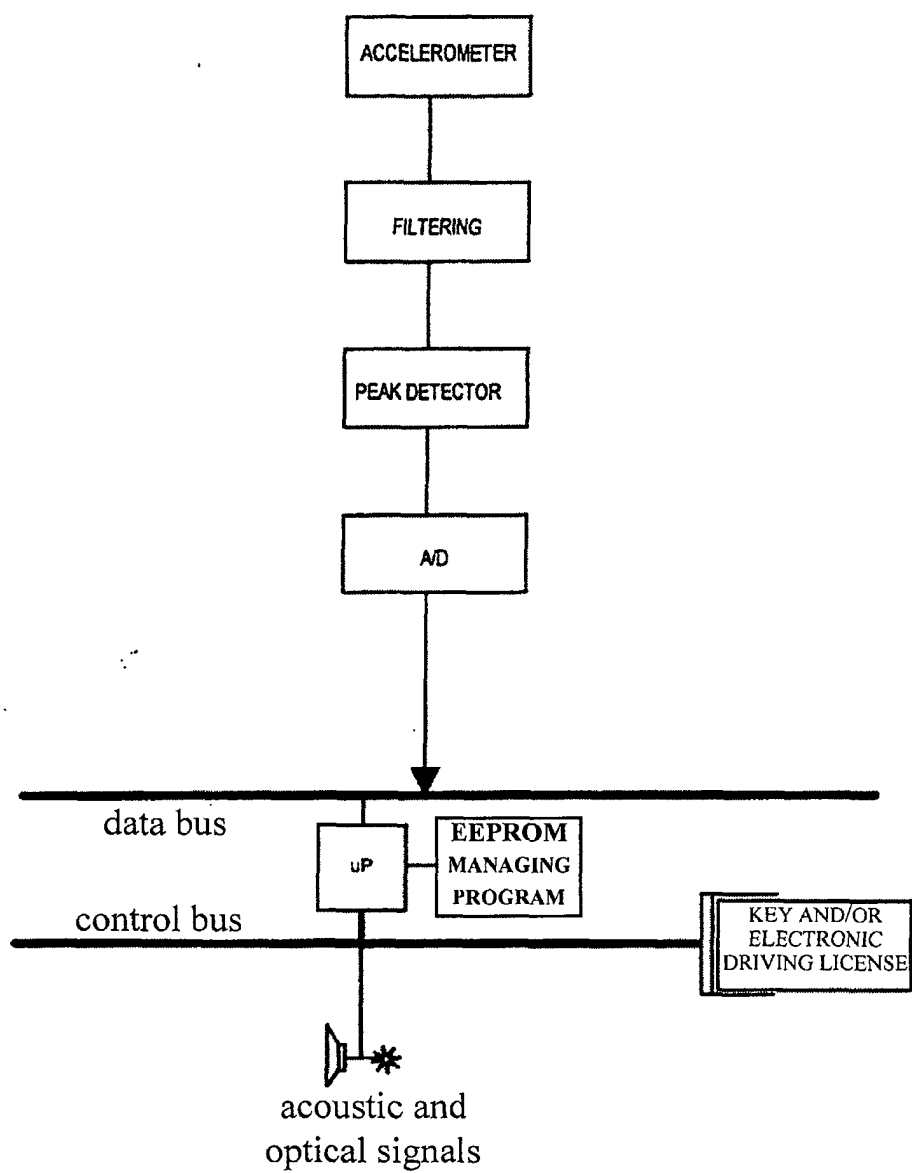


FIG. 3