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A METHOD AND A DEVICE FOR THE REGISTRATION OF THE MOVEMENT OF A VEHICLE

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(57) Claim

1. A method of registering displacement of a vehicle relative to the ground, said method including the steps of:

 providing camera means located at a distance above the ground, said camera means including at least one pair of video cameras spaced from each other in a direction substantially parallel to the plane of the ground;

 directing the camera means so that images produced by the cameras overlap each other at least partly to produce a pair of stereo images, so that when a vehicle is monitored by the camera means, contrasting fields in the images which represent parts of the vehicle that are spaced from the ground, appear displaced relative to a common reference;

 providing image processing means for comparing the displacement of the contrasting fields to a displacement which would be expected if the vehicle were replaced by an object not higher above the ground than the lowest vehicle likely to be monitored, the result of the comparison providing a positive indication of the position of the vehicle to facilitate tracking subsequent displacements of the vehicle.



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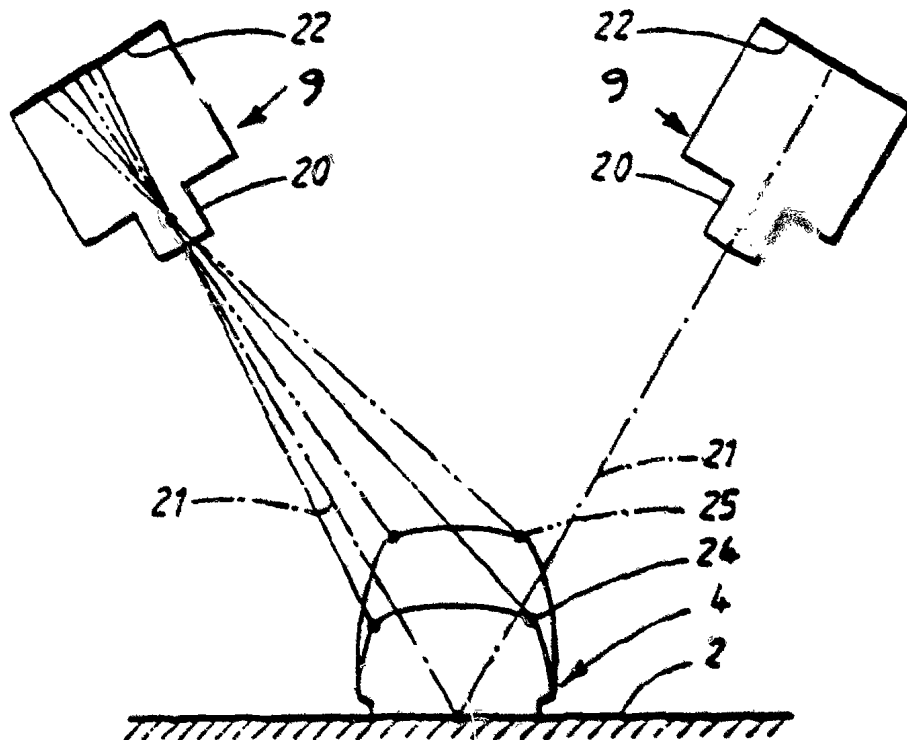
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(54) Title: A METHOD AND A DEVICE FOR THE REGISTRATION OF THE MOVEMENT OF A VEHICLE

(57) Abstract

A method and device for registering the successive positions of displacements of a vehicle by means of pairs of video cameras (9), which are located at a distance above the ground for the vehicle (2). The cameras are at a distance from each other and directed each so as to record the ground (2) as areas which overlap each other. Hereby, in the cameras, pairs of stereo records are produced, which are compared in an image processing. With the aid of the different positions for such vehicle contours (24, 25), which are located at different height levels above the ground, such a contour is selected which through substantial displacement between the two records is indicated to be located at a distance above the ground. This vehicle contour (25) is used in the image processing as an indicator in the tracking of the displacement of the vehicle.



A METHOD AND A DEVICE FOR THE REGISTRATION OF THE MOVEMENT OF A VEHICLE

~~TECHNICAL FIELD~~

The present invention relates to a method and device for registering the successive displacement of a vehicle. A foreseen and important area of application is the registration of the displacement of a vehicle in a road toll facility from a place of entry to a place where recording of the number plate or other characteristic of the vehicle can take place.

~~BACKGROUND~~

It is known to arrange road toll facilities for automatic fee debiting, see for example US,A,4,104,630 and US,A,4,303,904.

Thereby, it is understood that the majority of vehicles that pass the road toll station are provided with a receiver-transmitter unit for radiowaves, a so-called transponder. The road toll facility comprises an arrangement by which communication by radiowaves can take place with passing vehicles. This arrangement comprises transmitter and receiver, a transceiver, for the radiowaves by means of which equipment payment and debiting operations can be effected for the passing vehicles that are provided with said transponder. For this technique compare US A 4,075,332 and US A 4,242,661 for example.

However, it may occur, that the toll facility is passed by vehicles which are not provided with any transponder and therefore cannot be identified by means of the radiowaves. For identification of such vehicles, if these attempt at passing the toll facility without paying toll, the toll arrangement is provided with camera devices for image registration of the number plates of the vehicles in question for search and post-debiting. Such need be performed not only of vehicles that lack a transponder. If pre-payment is understood and sufficient means is lacking or if an approved payment operation cannot be performed for any other reason despite the presence of a transponder, post-debiting shall also be performed.

The most advanced system for road tolls of this kind is adapted to a great flow of traffic in free formation. In such an arrangement it will be



possible that the vehicle is displaced a certain distance from the time when a registration has been possible to make of whether the vehicle is identifiable through microwaves or not and until the recording of the number plate can occur.

During this displacement a differentiating must be maintained between such vehicles for which search and post-debiting shall take place, and such for which payment has been assured by means of a transponder. This requires that the toll facility is provided with an equipment for the registration of the successive forward displacement of the vehicle, so that it is ensured that the image is registered for the correct vehicle, i.e. a vehicle which on passing the road toll has been established to have dissatisfactory payment status. This positioning check shall thereby be effected while several vehicles travel in a free flow with possible lane changes when passing through the road toll facility. The check shall be possible to perform of the vehicle at full speed whereby a very short time is available.

In order to perform this positioning check during the displacement in the toll facility and through the recording site it has been suggested to use induction loops in the roadway. With the aid of these it is possible to detect the displacement of the metal mass of a vehicle and follow the displacement of the vehicle in the direction of travel and also detect possible side displacements.

Such a device is however expensive and difficult to install as it must be countersunk into the roadway. It is also difficult to render it sufficiently selective, so as to in effect guarantee that no confusion between vehicles moving in a complex movement pattern at high speed occurs. Moreover, certain vehicles such as motor cycles can be difficult to register at all.

DESCRIPTION OF THE INVENTION

In the invention, video cameras are used for the registration, arranged at a distance above the roadway. In the image planes of the cameras



providing camera means located at a distance above the ground, said
5 camera means including at least one pair of video cameras spaced from each
other in a direction substantially parallel to the plane of the ground;

providing image processing means for comparing the displacement of the contrasting fields to a displacement which would be expected if the vehicle were replaced by an object not higher above the ground than the lowest vehicle likely to be monitored, the result of the comparison providing a positive indication of the position of the vehicle to facilitate tracking subsequent displacements of the vehicle.

camera means located at a distance above the ground, said camera means including at least one pair of video cameras spaced from each other in a direction substantially parallel to the plane of the ground and directed so that images produced by the cameras overlap each other at least partly to produce a pair of stereo images, so that when a vehicle is monitored by the camera means, contrasting fields in the images which represent parts of the vehicle that are spaced from the ground, appear displaced relative to a common reference; and



- 3a -

position of the vehicle to facilitate tracking subsequent displacements of the vehicle.

A preferred embodiment of the present invention will now be described with reference to the accompanying drawings wherein:-

- 5 Fig. 1 shows in perspective a road toll arrangement;
Fig. 2 shows a block diagram for the main functions of the arrangement;

A 4x4 grid of black dots forming the number 2538. The digits are composed of small black dots arranged in a grid pattern.



ALL INFORMATION CONTAINED HEREIN IS UNCLASSIFIED

Fig. 3 shows schematically an arrangement of two video cameras for said registration of the successive displacement;

Fig. 4 shows two superimposed stereo records;

Fig. 5 shows these two stereo records brought together; and

Fig. 6 shows a position of displacement of the vehicle other than that shown in Fig. 5, that is when the vehicle has reached the recording site.

~~PREFERRED EMBODIMENT~~

According to Fig. 1 an automatic road toll facility according to the invention is provided with a gantry 1 which extends above a road 2, which has three lanes 3 in which vehicles 4 of different kinds can proceed through the portal-like gantry 1. The traffic is not limited to keeping in a lane but is allowed to perform lane changes and over-takings. It is thus a free-flow system, which as little as possible shall disrupt the traffic flow.

On the gantry, there are attached two light fittings 6 and a number of transmitter and receiver units 7 for microwaves, three of which are shown here, including antennae for these. In addition, there is on either side a video camera 8, directed at the approaching traffic flow to register vehicles which unpermittedly are driven on the verge. In addition, at the top center of the gantry a pair of video cameras 9 are shown, directed downwards at the traffic flow. Alternatively, several such pairs of cameras can be arranged. Furthermore, cameras 10 in three pairs of video cameras 10 are directed towards and away from the traffic flow. These pairs of cameras are shown located approximately at the centre of the respective lane 3. In each pair one of the cameras is directed against and one along the direction of the traffic flow.



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All this equipment is connected to a central facility 11 for the control of same and for processing recorded data. This central facility is in turn connected to a central net for further communication.

The main functions and function units of the arrangement are evident from the block diagram in Fig. 2. Therein, 12 designates the equipment understood to be provided in the majority of vehicles 4.

Such an equipment can be a transponder unit 13, which is arranged to pick up microwaves and transform them into an answer signal comprising information for the identification of the vehicle, and in addition, an intelligent card for transmitting data via the transponder, which data in addition to certain identification data, can consist of data regarding payment conditions (if debiting shall occur or if pre-payment via a pay card 14, smart card, has been made).

Other elements in the block diagram relate to the stationary equipment. On the gantry there are located the transmitter and receiver equipment 7 for microwaves, video cameras 8 and the camera pair 9 as well as the video cameras 10, which are all identified by the same numbers in the block diagram. Other elements belong to said equipment with which the equipment on the support communicates. This equipment can comprise a unit 11 for checking the transmitter and receiver equipment 7 and which controls the debiting of vehicles which are provided with the equipment 12.

In addition, there is said equipment for checking vehicles which are not provided with any unit 12-14 and for which there is a need for identification in a different way, and examination for post-debiting. This equipment comprises the camera pair 9 for the detection and tracking of vehicles which lack the correct equipment 12, and video cameras 10 (only two of which are shown) for recording the number plate of the vehicles that shall be checked particularly. Video cameras 10 are connected to the unit 11 for controlling the exposure of the vehicles that shall be checked particularly and for collecting registered video records, and possible compression and storing of same. These records can be

communicated to a central facility 16 for post-processing in connection with search and post-debiting of vehicles that have passed without paying.

Broadly, except for the arrangement with the cameras 9, this system corresponds to what has been stated in the introduction as known. However, there is within the system a part solution that relates to the system for the successive position registration of vehicles between the place of entry into the road toll facility and registration of the identification images. This part solution forms the basis for the subsequent Claims, and shall be described in the following.

As mentioned, registration of debiting shall take place, in the ordinary case through subtraction from a pre-paid card, smart card, when the vehicle passes the road toll facility. This case leads to the following operational steps:

The vehicle approaches - the microwave transmitter is activated.

Command is transmitted - the transponder of the vehicle answers
- the microwave transmitter registers the position of the vehicle and checks payment status.

Debiting occurs - through activation from the transponder the debiting is registered in the vehicle.

Reporting to the central unit of performed transaction.

If however the vehicle is not equipped for automatic fee debiting or does not have approved payment status, means lacking on the card or an account not having been approved, the vehicle must be registered through video recording of its number plate. This shall occur when the vehicle is in a certain position, the recording site, relative to the respective cameras 10. From the moment when the position of the vehicle has first been registered and until the vehicle has come in position for recording, it shall be tracked. Such tracking or successive position registration must be possible to perform, irrespective of the speed

of the vehicle, changes in speed and changes in the direction of travel. Recording for post-processing shall only, under maintained identification, be registered for such vehicles for which no approved fee debiting has been performed by means of the described interaction between the microwave transmitter and the vehicle equipment with its transponder.

The successive position registration is performed with the aid of the video cameras 9, the pair of cameras co-operating with an equipment for image processing. The operational sequence for the camera units and the image processing equipment comprises the following steps:

Activation occurs either via the microwave transceiver and/or directly in that the vehicles enter the image field of any one of the cameras 9.

The successive position registration by means of the cameras is initiated.

The position, such as it appears from the position in the image field of the two co-operating cameras, is correlated to one in the same moment, with the aid of the position that the microwave transceiver can register for vehicles provided with a transponder.

If through the microwave transceiver approved payment is registered, the system is made passive for the successive position registration of the vehicle in question.

If however approved debiting could not be performed, the successive position registration of the vehicle in question continues.

Along the contour of the registered vehicle a marker is placed on the spot where a number plate is supposed to be located - possibly a marker can be placed both in the position of the front number plate and of the rear number plate.

In the image field there is a fixed marking for the image field of the recording camera or cameras.

When the vehicle marker has reached the marker of the recording camera it is activated for the recording of the number plate or plates of the vehicle.

The recording can be connected to a registration of data such as time and place and data regarding the vehicle such as its type (passenger car, bus, truck, motor cycle).

The produced records are stored for processing, so that post-debiting of the toll and possible fine can be effected.

According to the here given flow scheme only the vehicles that by means of microwave communication have been stated not to have approved payment status are recorded. This means that the vehicle must be tracked while the payment and checking operation is performed upto the recording site. This gives a relatively extended toll facility area since the payment operation requires a certain time during which a fast vehicle travels a relatively long distance. To this distance adds the distance that is required for the recording site. In the whole distance, tracking must be performed which gives a correspondingly extended monitoring area for the video cameras.

In an alternative solution, the number plates of all incoming vehicles are recorded and tracked thereafter during the payment operation including the checking operation of payment status. The recorded vehicles can hereafter be separated into two groups, firstly such that can make the correct payment and secondly such that cannot. For the latter the recording of the number plates are given a special marking which indicates that post-debiting shall be performed. Preferably, this marking occurs in that only these records are registered finally while all others are deleted from the storing means, which can be a magnetic disc for example. By performing the payment checking and recording operation in this way

along the same distance, the total distance for the operational area of the toll arrangement is reduced.

Which one of these two described operational sequences is chosen does not affect the main function of tracking the vehicle by means of the camera pair 9.

Even if recording the number plate or other characteristic is understood here, it does not exclude that recording can be performed in any other way, for example by reading the number code of the plate or any other code.

In the following, the image processing shall now be described from the time when both video cameras in the pair 9 are activated until the successive position tracking has been concluded when the payment status of the vehicle has been established and possibly registered.

In the successive position registration, by electronic processing of the images of the video cameras only, there are certain problems, which must be eliminated. The major problem is how the contour and contrasts within the vehicle could be separated from other contours and contrasts in the image field, which do not represent this particular vehicle. Such contours can appear through shadows from objects in the surroundings and above all movable shadows from simultaneously passing vehicles. In addition, there may be reflections, especially at rainy weather. Such phenomena appear on or immediately above the roadway, while every vehicle that shall be registered has a certain height. Consequently, only the contours of objects that are present with any portion at a certain height above the roadway are recorded and tracked, said height however not being in any way predetermined; vehicles of many different kinds can pass the road toll facility. How this is achieved is evident from the following, wherein Fig. 3-6 are referred to.

In Fig. 3 it is shown, in a view seen in the horizontal direction, a portion of the road toll gate in Fig. 1. For identical functional parts the same designations have been used; thus represented are the road

toll gantry 1, the roadway 2 and a vehicle 4, as well as two video cameras 9, which jointly form said unit. Fig. 3 is more schematic than Fig. 1 and has not the same proportions.

The two video cameras are directed so as to overlap each other's image field at least in part. They are located at a distance from each other and the overlapping is achieved in that they are directed with their objectives 20 towards each other. Suitably, they are so directed that their respective central axes 21 through the objectives meet each other in the roadway 2. From this follows that in the image planes 22 of the two cameras, a stereo record appears, i.e. two records that show the object in question from two different angles.

By such recording with cameras at a distance from each other and with overlapping image fields, an imagined plane can be laid through the respective objectives, which two planes intersect in a determined line at a distance from the cameras. In the arrangement shown in Fig. 3 it is shown for the left camera that this plane is located in the central axis 21 of the objective, and thereby forms a centre line to the image plane 22. The right camera 9 is directed in the same way. The setting of the cameras is such that these central planes hit each other in the roadway 2 right at the centre between the cameras. The imagined planes are perpendicular to the plane of the paper. Hereby, the records produced by the two cameras of the roadway and only of it, will correspond almost completely.

In positions above the roadway, however, the records in the two cameras differ more and more from each other the higher above the roadway the recorded portion is located. This is shown by additional lines at the left camera. So it is shown, how the contour of an area 24, which shall mark the front or rear portion of the vehicle (on a saloon model), will displace itself relative to the plane 21 of the central axis. The portion 25, which is intended to designate the roof of the vehicle will be placed even more out of centre relative to the central axis 21. In the other camera the same phenomenon appears, but here the displacement occurs

relative to the central axis in the opposite direction. Recording in this way is called stereo recording.

This is illustrated in Fig. 4 in which it is shown how a conceived image produced by superimposing the records of the two cameras would look. It is evident that the contours 24 have been displaced outwards away from each other and the contours 25 have been even more displaced from each other. By processing the image signals from the two cameras, which is suitably performed digitally, contours can be detected which are located at a considerable distance from each other, i.e. contours of portions which are located at a certain height above the roadway. Suitably, larger areas are selected high up, suitably the roof of the vehicle or in case of trucks the upper surface of the cargo. By selecting in this way by means of stereo recording a high portion, at a certain height, of a vehicle for a detection of its position, the effect of said disturbances by shadows and reflections in the plane of the roadway can be eliminated.

In the next step of the image processing the contours are joined with a special marking of the contour 25, which has been selected for positioning. This is illustrated in Fig. 5. By tracking the marked contour 25 the successive position displacement of the vehicle can be successively registered through further image processing.

In order to record the place on the vehicle where the number plate is attached, a marker 26 is attached to this place. By marker it is here meant a field in a determined position relative to the contour 25, which in the image processing is used for the successive registration of the position of the vehicle. As mentioned, the marker is placed over the external contour 24 of the vehicle and encircles the area where the number plate is supposed to be located. In Fig. 5 it is suggested that the rear number plate of the vehicle is intended. One of the cameras¹⁰ shown in Fig. 1 that are directed in the direction of travel of the passing vehicles can thus catch the rear plate within its image field. If desired, the front number plate can alternatively or additionally be recorded. In Fig. 1 a further arrangement of recording cameras is shown. In this case, a marker is also positioned at the front contour line of the vehicle.



At the toll facility shown in Fig. 1 it is understood that the recording of both the front and rear number plates of the vehicle shall occur, which is evident in that the cameras 10 have been stated to be separated in forward-directed and backward-directed cameras, relative to the direction of the traffic flow.

The marker can be given the shape of a field or frame inserted as a part of the recording in the image field of the camera and movable along with the contour of the vehicle during its displacement. Alternatively, in the image processing program the marker can be defined with coordinates starting out from the contour 25.

In the image field of the camera there is one additional or several markers 28. With rigidly mounted cameras, the markers are located at fixed places in the image field. Similar to the marker 26, the marker 28 can be inserted in the image field or expressed as fixed coordinates for example. Each marker 28 designates an area of recording for the recording cameras 10.

During the successive displacement of the vehicle, its recorded contours are also displaced through the locking of the image processing computer to the contrast field within the selected contour 25 by the image processing computer. This, eventually, causes the marker 26, which is fixed to the vehicle contour, to be displaced in the image field into the area for the respective marker 28, which represents the image field of a recording camera 10. A recording position has thereby been obtained. This is detected by the computer, and activation of the recording camera occurs, so that an exposure of the number plate of the vehicle is made.

The produced image is stored for example on a computer disc or is transmitted to the central computer 16 for storing.

In the arrangement shown in Fig. 1 according to the secondly mentioned alternative, recording of the front number plate is made in the place where the activation of the microwave transceiver 7 occurs and the rear plate is recorded after the vehicle has passed the gantry 1. The recording

shall then in the first case be made when the front number plate 26 of the vehicle passes the marker for one of the cameras 10 directed at the traffic flow and the recording of the rear number plate when its marker passes the marker for the cameras directed along the direction of the traffic flow.

Later, a reading of the stored records and post-debiting of the vehicle fee and possible fine is effected. Suitably, each record is connected to certain data produced in connection with the process, such as time and place, the status of the vehicle, provided with or lacking transponder, and also vehicle type.

Checking the vehicle type can be of interest for determining the amount of the fee. Although the vehicle type should be possible to read out, with the aid of the number plate, from the authority vehicle register, a special detection of the vehicle type provides a possibility to check that any exchange of number plates between different vehicles has not occurred.

For detecting which category, passenger car, bus, truck or motor cycle, the vehicle in question belongs to, the equipment for the successive position displacement can be used. This equipment provides, as described, a reading of the height conditions of the vehicle through indication by means of the contour displacements between the two stereo records, compare Fig. 4. The greater the displacement, the higher the portion in question of the vehicle. By using the degree of this displacement in the image processing, a height graph for the vehicle can be produced. This will for different categories of vehicles have a characteristic appearance and dimension. So, a passenger car of modern saloon-type has a front and a rear lower portion, the bonnet and the luggage boot, and inbetween a higher portion, the passenger space. A bus, on the other hand, has usually an almost vertical front and rear portion and inbetween a relatively plane roof. With such shapes as a basis the recorded height graphs can be detected and fitted into a vehicle category. Other image elements as well, created through contrasts in different image fields

within the vehicle contour can be used for determination of the vehicle category.

The method according to the invention of tracking and detecting the successive displacement of a vehicle by means of video recording comprises the recording of stereo images and by comparing these establishing a contour of the vehicle that is present at a distance from the roadway on which the vehicle moves. This contour or any part of same or additional contours are thereafter used as the image part to which locking occurs and through whose the displacement in the image field the vehicle movement can be registered.

In Fig. 3 the principle of the stereo recording is shown in a symmetrical arrangement. The cameras 9 are so directed that the central axes 21 of the objectives hit each other in a mutual point in the roadway 2. The vehicle 4 in turn is symmetrically located relative to this point. Especially the latter should occur more seldom in reality. The vehicle can have different positions sideways within the operational field of the cameras. This leads to a displacement of the vehicle contour within the image field. In spite of this, the described main principle for position registration can be used. This is true even if the camera arrangement should not be entirely symmetrical or if any other axis through the objectives than the central axis should be used as the axes of reference which shall intersect each other in the roadway.

The described image processing has been designated as to its main steps. Further steps can be added such as correction of the real image on the image field of the camera,, which can be distorted, into a correct shape on the image field of the camera. Other processing steps can also be added without deviating from the basic principle.

In a camera pair several vehicles can be tracked and registered simultaneously. If change of lanes occurs, the vehicle must despite this fact be possible to track. Thereby, it is either required that one camera pair covers all the lanes or that the image processing allows the transfer of a vehicle image between several camera pairs. In the former case

the arrangement can be reduced to one camera pair if the whole roadway is covered by it.

At the first designated alternative it was supposed that only the vehicles that shall be searched, are tracked and recorded. However, deletion of the record can be performed at any step of the process, and according to the second alternative all vehicles can be tracked and recorded but storing only images of vehicles that shall be searched for.

For selecting such images that shall be post-processed, the transceiver equipment 7 must work with the detection of vehicles provided with a transponder. By means of several antennae the position of a vehicle entering the operational area of the toll facility can be estimated. This is used for correlating the vehicle identification in the microwave and camera systems, respectively. A preferred method of operation is that the cameras 9 catch all vehicles, when they enter the image field. Simultaneously, the microwave system performs its checking and debiting operation. When acceptance of this has been registered, which provides that the vehicle has a unit 12, the momentary position of the vehicle is calculated by the microwaves. This position can now be correlated to the position of the corresponding vehicle in the image processing. Thereby, this vehicle can be eliminated from the search process.

Finally, it shall be mentioned that the cameras 8 at the verge are suitably arranged to record all vehicles that are driven on the verge of the road. Such traffic should always be considered unpermitted if it is not a case of working vehicles and certain official vehicles.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A method of registering displacement of a vehicle relative to the ground, said method including the steps of:

5 providing camera means located at a distance above the ground, said camera means including at least one pair of video cameras spaced from each other in a direction substantially parallel to the plane of the ground;

directing the camera means so that images produced by the cameras overlap each other at least partly to produce a pair of stereo images, so that when
10 a vehicle is monitored by the camera means, contrasting fields in the images which represent parts of the vehicle that are spaced from the ground, appear displaced relative to a common reference;

providing image processing means for comparing the displacement of the contrasting fields to a displacement which would be expected if the vehicle were
15 replaced by an object not higher above the ground than the lowest vehicle likely to be monitored, the result of the comparison providing a positive indication of the position of the vehicle to facilitate tracking subsequent displacements of the vehicle.

20 2. A method according to Claim 1, when used in a road toll facility for automatically performing a toll debiting operation on passing vehicles, said method being applied to monitoring/recording of the number plate or other characteristic of a vehicle when the vehicle has reached a recording site associated with the toll facility, wherein the image processing means links at least
25 one monitoring marker to a position in the contrasting field in which the number plate or other characteristic of the vehicle is expected to be located and wherein the recording site includes a recording marker such that the camera means is activated to perform a recording when the image processing means detects that the monitoring marker linked to the vehicle coincides with the recording marker at
30 the recording site.



3. A method according to Claim 1 or 2, including the steps of processing displacement of the contrasting fields in the stereo images associated with a vehicle being recorded to produce a characteristic signature for the vehicle, and comparing the vehicle signature with a data base of signatures for vehicles in
5 different categories, such as passenger cars, buses, trucks and motor cycles to produce data indicating the probable category belonging to the vehicle being recorded.

4. A method according to Claim 1, 2 or 3, when used in a road toll facility for
10 automatically performing a toll debiting operation on passing vehicles, said method being applied to monitoring/recording of the number plate or other characteristic of a vehicle passing the toll facility, said method including the steps of monitoring a vehicle when it enters the toll facility, tracking subsequent displacements of the vehicle at least until ability to perform toll debiting is
15 established and recording the number plate or other characteristic of the vehicle if the toll debiting operation is unable to be performed.

5. Apparatus for registering displacement of a vehicle relative to the ground, said apparatus including:

20 camera means located at a distance above the ground, said camera means including at least one pair of video cameras spaced from each other in a direction substantially parallel to the plane of the ground and directed so that images produced by the cameras overlap each other at least partly to produce a pair of stereo images, so that when a vehicle is monitored by the camera means,
25 contrasting fields in the images which represent parts of the vehicle that are spaced from the ground, appear displaced relative to a common reference; and

image processing means for comparing the displacement of the contrasting fields to a displacement which would be expected if the vehicle were replaced by an object not higher above the ground than the lowest vehicle likely
30 to be monitored, the result of the comparison providing a positive indication of the position of the vehicle to facilitate tracking subsequent displacements of the vehicle.



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10. Apparatus according to Claim 7, 8 or 9 wherein said at least one video
5 camera is arranged to monitor vehicles entering an operational area of the toll
facility and wherein said image processing means is arranged to track successive
displacements of a vehicle for substantially the entire distance that the vehicle
travels while the toll debiting operation is being performed, each operation being
referred to a specific vehicle, said recording means being arranged so that only
10 vehicles on which the toll debiting operation is unable to be performed are
recorded.

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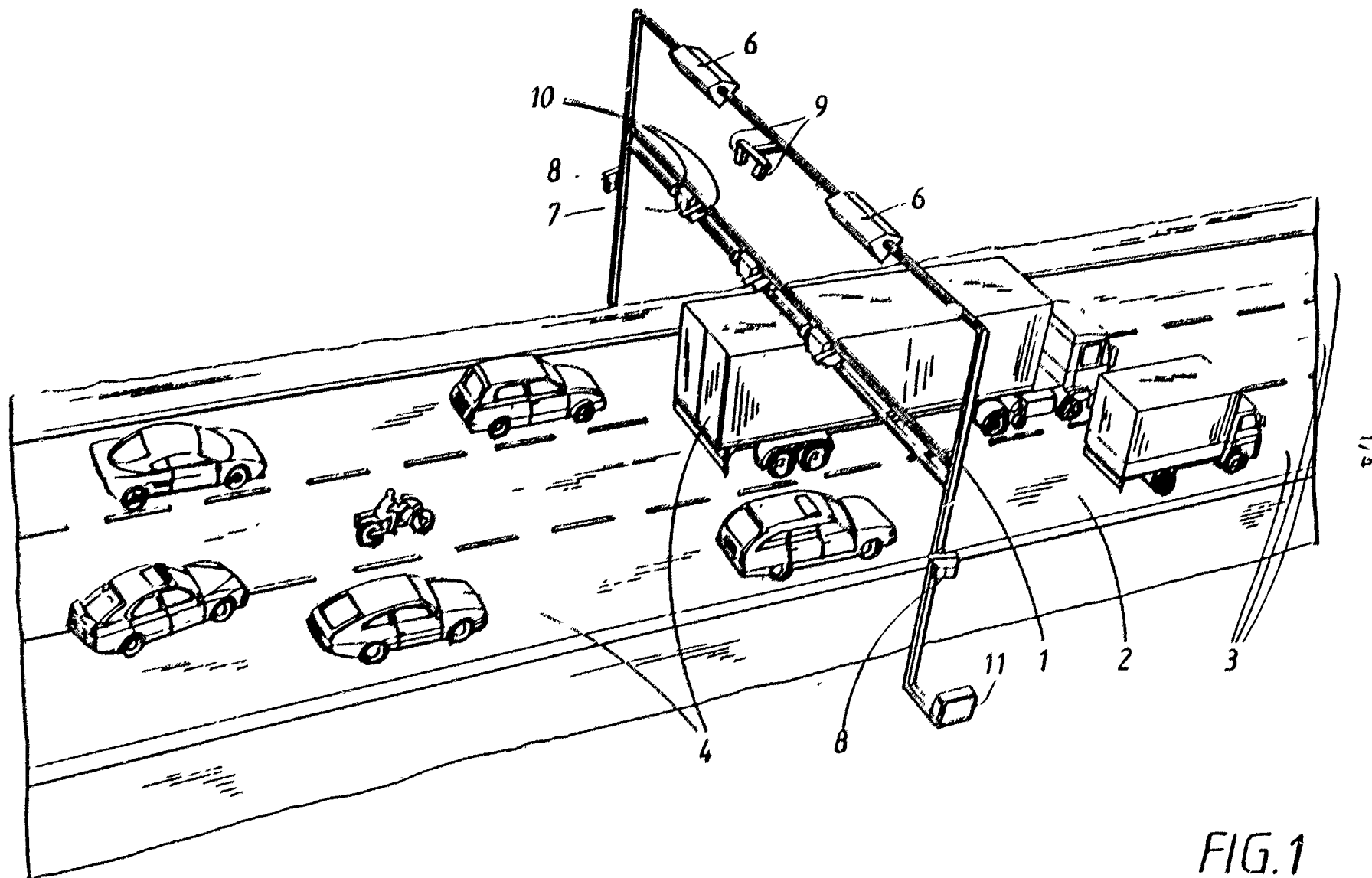


FIG. 1

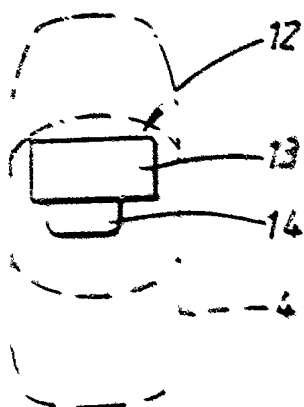
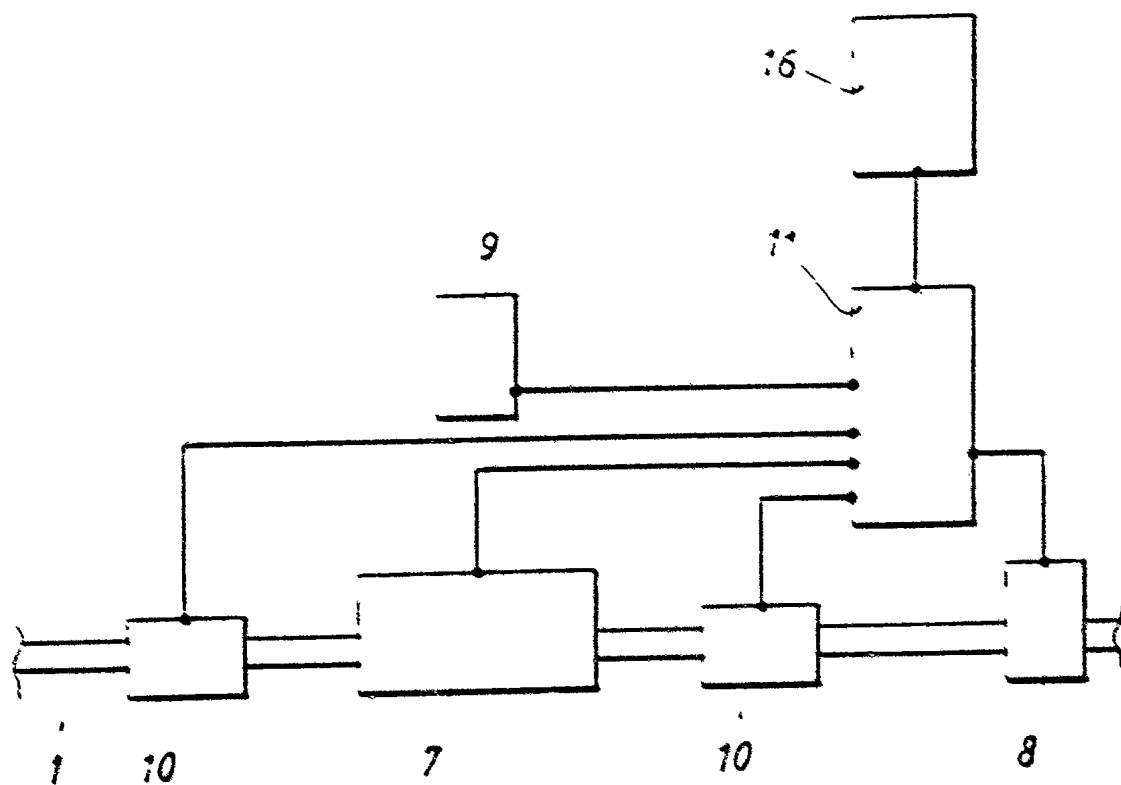


FIG.2

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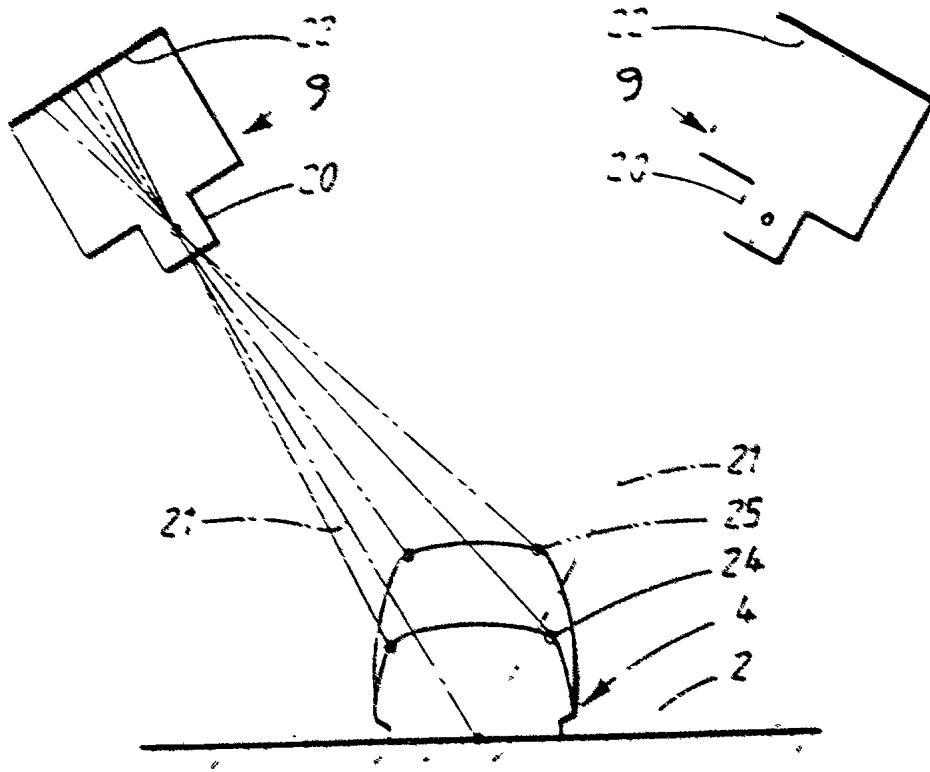


FIG. 3

3.4

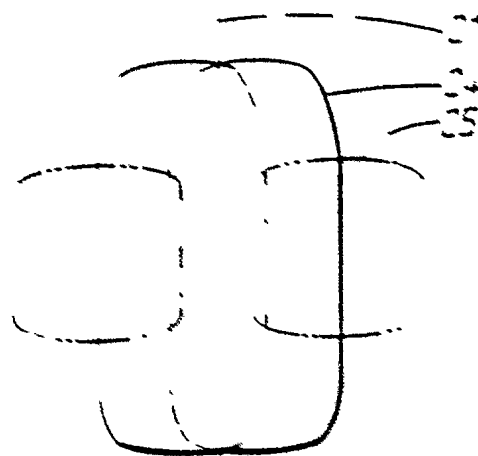


FIG. 4

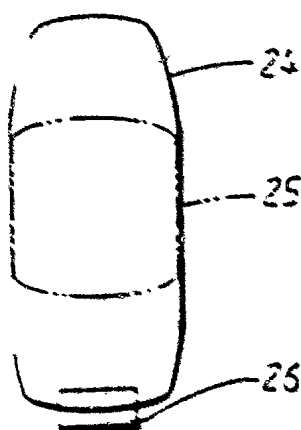


FIG. 5

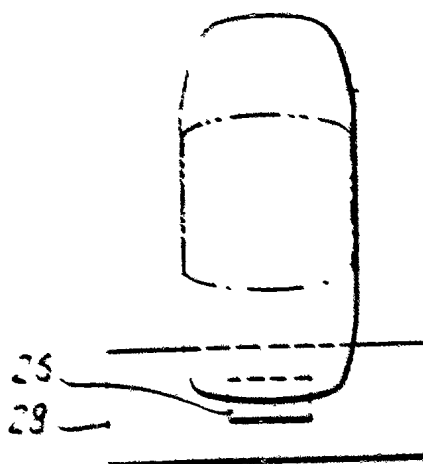


FIG. 6

INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 94 00503

A. CLASSIFICATION OF SUBJECT MATTER

IPC: G01C 11/02, G07B 15/00, G07C 9/00, G08G 1/017

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: G01C, G07B, G07C, G08G

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

SE,DK,FI,NO classes as above

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	Patent Abstracts of Japan, Vol 9, No 127, P-360, abstract of JP, A, 60-10112 (NIPPON DENKI K.K.), 19 January 1985 (19.01.85)	1,5
A	--	2-4,6-9
X	Derwent's abstract, No H8658 D 34, week 8134, ABSTRACT OF SU, 777427 (GOGOLEV V A), 21 November 1980 (21.11.80)	1,5
A	--	2-4,6-9
A	WO, A1, 9014640 (AUSTRALIAN ELECTRO OPTICS PTY LTD), 29 November 1990 (29.11.90), page 7, line 18 - line 26, figure 4	1-9
	--	

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex

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* "Z" document member of the same patent family

Date of the actual completion of the international search

8 Sept 1994

Date of mailing of the international search report

12 -19- 1994

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 94/00503

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB, A, 2219881 (ENGLISH ELECTRIC VALVE COMPANY LIMITED), 20 December 1989 (20.12.89), page 2, line 6 - page 3, line 8; page 8, line 2 - line 7, figure 4, abstract --	1-9
A	US, A, 4555618 (BERNARD N. RISKIN), 26 November 1985 (26.11.85), column 6, line 26 - column 7, line 4, figure 1 --	1-9
A	US, A, 5204675 (HIROYOSHI SEKINE), 20 April 1993 (20.04.93), figure 2, abstract -----	1-9

INTERNATIONAL SEARCH REPORT

Information on patent family members

30/07/94

International application No.

PCT/SE 94/00503

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
WO-A1-	9014640	29/11/90	NONE		
GB-A-	2219881	20/12/89	EP-A-	0347090	20/12/89
US-A-	4555618	26/11/85	NONE		
US-A-	5204675	20/04/93	JP-A-	4000920	06/01/92