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(54) **A SYSTEM FOR PREVENTING VEHICLES FROM DRIVING IN THE WRONG DIRECTION**

(57) The object of the invention is a system for preventing vehicles from driving in the wrong direction. The system according to the present invention warns the driver of wrong-way driving and at the same transmits a live real-time image to competent authorities informing them about the violator and the exact location of the violation. Additionally, the presented system also provides for alerting the drivers who drive in the right direction that there is a vehicle driving in the forbidden direction at the exit. The system includes at least one central camera (1), a control and communication unit (2) and at least one first warning device (3), wherein the central camera (1) is positioned so that the viewing angle of the camera completely covers a predefined zone (4) of the roadway with a defined entry line (5). The control and communication unit (2) includes at least one central processing unit, on which a programme module is implemented, which controls the system in accordance with a pre-loaded computer programme, namely on the basis of an image transmitted from the central camera (1) detects the vehicle's wrong-way driving and transmits the recordings of the event, live, to the competent authorities, simultaneously stores them to an external memory and transmits an adequate signal to the warning devices.

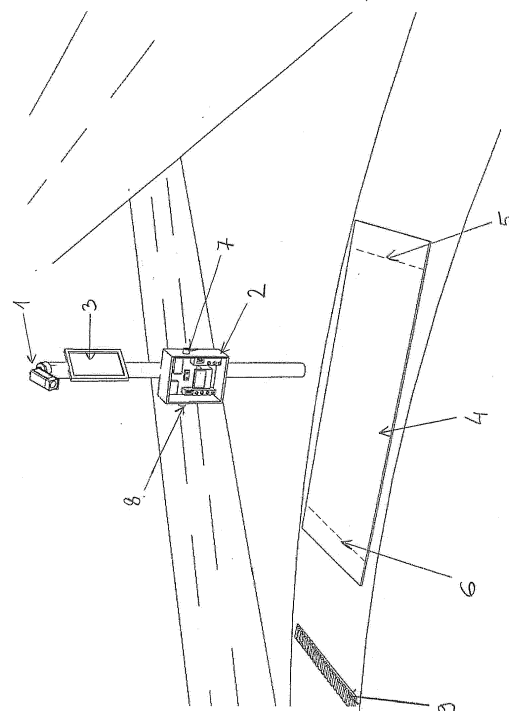


Fig. 1

Description

[0001] The object of the invention is a system for preventing vehicles from driving in the wrong direction. The system according to the invention, in addition to warning the driver of wrong-way driving, also allows for physically stopping a vehicle driving in the opposite direction as allowed by traffic signals, in particular in the direction of access to a motorway.

[0002] The technical problem solved by the present invention is to configure a system which first warns the driver of wrong-way driving and at the same time informs the competent authorities, such as the relevant call centre and/or the police, by transmitting a live image so that the competent authorities can receive real-time information about the violator and the exact location of the violation.

[0003] Additionally, the presented system also provides for alerting the drivers who drive in the right direction, i. e. who want to use the exit from the motorway correctly, that there is a vehicle driving in the forbidden direction at the exit.

[0004] In addition, the presented system also allows for physical stopping a vehicle driving in the forbidden direction in the event that the driver continues to drive in the forbidden direction despite warnings.

[0005] Various systems and devices are known from prior art that detect vehicles driving in the wrong direction and trigger road obstacles that physically stop the vehicle.

[0006] U.S. Pat. No. 4,320,380 discloses a system that electronically controls the lifting and lowering mechanism of a protective ramp when motion sensors provided within the roadway detect a vehicle driving in the wrong direction.

[0007] Patent SI 23220 discloses a device that includes spring elements which enable the physical stopping of a wrong-way driving vehicle.

[0008] There are systems that include video cameras that record the direction of driving of vehicles and allow communication to control centres, but more for the purpose of determining traffic throughput or determining traffic congestion on a motorway due to various factors.

[0009] The applicant is not familiar with any systems that would include video surveillance with a possibility of informing the competent authorities about violators and at the same time a possibility of using floor barriers that also provide for physically preventing wrong-way driving vehicles from continuing the ride.

[0010] The technical problem solved by the present invention is detection of a wrong-way driving vehicle, warning the driver of wrong-way driving and at the same time transmitting information about the wrong-way driving vehicle with the exact location to the competent authorities. Additionally, the system also provides for the transmission of information about the violator, namely by taking a picture of the driver's face and the vehicle's licence plate number.

[0011] If necessary, the system also allows for physical stopping a vehicle in a safe way, which significantly improves road safety, especially a safe access to and exit from the motorway.

[0012] The invention will be described in more detail herein below and illustrated on the figures which show:

Figure 1 shows an embodiment of a system according to the invention set up at a motorway exit

Figure 2 shows an embodiment of a control and communication unit

Figure 3 shows an embodiment of determining the direction of travel of a vehicle that triggers a wrong-way driving alarm, and determining initial parameters of triggering an alarm at the input image of the roadway zone detected by a central camera

Figure 4 shows an embodiment of a floor barrier.

[0013] The system according to the invention shown in Figure 1 includes at least one central camera 1, a control and communication unit 2 and at least one first warning device 3, wherein the central camera 1 is connected to the control and communication unit 2 and positioned so that the viewing angle of the camera completely covers the relevant part of the roadway, i. e. a predefined zone 4 of the roadway with a defined entry line 5, and wherein the first warning device 3 is connected to the control and communication unit 2 and positioned to be visible to the driver when crossing the entry line 5, and before the vehicle travels over a mechanical floor barrier 9.

[0014] The zone 4 of the roadway comprises an exit roadway of a length of at least 10 m and is preferably defined so that the entry line 5 of the roadway zone 4 is located as close as possible to the end of the motorway exit. In this way, a wrong-way driving vehicle can be detected practically when the vehicle enters the motorway exit.

[0015] The central camera 1 is placed at the exit of the motorway, namely at the edge of the roadway exit, approximately in the middle of the roadway zone 4, so that the central camera 1 can detect a wrong-way driving vehicle as soon as possible. In this way, the driver can be warned of wrong-way driving even before the vehicle reaches the beginning of the exit from the motorway and, if necessary, can be stopped in good time. Within the context of this application, the end of an exit of a motorway refers to that part of the exit that is travelled first by the wrong-way driving vehicle. Within the context of this application, the beginning of an exit of a motorway refers to that part of the exit that is travelled first by a vehicle driving in the right direction.

[0016] Preferably, the central camera 1 is located at a distance of maximum 10 m from the end of the motorway exit.

[0017] The central camera 1 is placed at a certain

height above the exit roadway or above the roadway zone 4, so that the viewing angle of the camera 1 covers the entire predetermined roadway zone 4, and that the camera 1 can also detect taller vehicles, such as trucks and buses. Preferably, the central camera 1 is located at a height of 7 m above the roadway.

[0018] The first warning device 3 is placed at a distance from the end of the motorway exit so that wrong-way drivers are warned in good time that they are driving in the wrong direction. Preferably, the first warning device 3 is a LED display.

[0019] In a preferred embodiment, the central camera 1 and the first warning device 3 are arranged equidistantly from the end of the motorway exit.

[0020] Optionally, the system additionally includes at least one front camera 7, i. e. a camera facing in the wrong direction of driving and connected to the control and communication unit 2 and positioned to capture the front section of the vehicle and the driver's face for possible subsequent facial recognition or reading the license plate.

[0021] Optionally, the system additionally includes at least one rear camera 8, i. e. a camera facing the correct direction of driving and connected to the control and communication unit 2 and positioned to capture the rear section of the vehicle for possible subsequent reading the license plate.

[0022] In a preferred embodiment, the system further includes a front 7 and a rear camera 8. As there are two cameras and they record both the front and rear sections of a wrong-way driving vehicle, the possibility of identifying the vehicle based on a license plate image and driver identification is significantly improved.

[0023] All cameras 1, 7, 8 continuously record the events in the roadway zone 4, the recordings being stored in an internal memory 22 located in the control and communication unit 2, and deleted after a certain period of time. In the event a wrong-way driving alarm is triggered, the recordings from all cameras 1, 7, 8 are transmitted live to the control centre of the competent authorities and at the same time to the external memory for a subsequent analysis. In this way, the competent authorities obtain real-time information about the violator and the exact location of the violation.

[0024] The cameras 1, 7, 8 are preferably high-quality day and night cameras resistant to weather conditions with protection against rain, snow or sun, so that adequate image quality is guaranteed in any weather.

[0025] Optionally, the system further includes at least one second warning device 31 (not shown in the figure) which is connected to the control and communication unit 2 and is located at a distance from the start of the exit from the motorway, so that drivers wishing to leave the motorway in the right direction are warned in time about the exit being closed. Preferably, the second warning device 31 is a LED display.

[0026] The control and communication unit 2 includes:

- at least one central processing unit 21 on which a program module is implemented, which controls the system in accordance with a pre-loaded computer programme;
 - an internal memory 22 for recordings;
 - a communication module 23 for wireless connection of the control and communication unit 2 with a surveillance central unit located at the competent authorities (e. g. the Slovenian Motorway Company - DARS, police) and for connection with at least the first warning device 3;
 - a power supply 24 which can optionally be via a battery.
- [0027]** The wireless connection of the communication module 23 with the surveillance central unit is preferably carried out via an Internet modem with a SIM card.
- [0028]** When the system further includes at least one second warning device 31, this latter is also connected to the communication module 23.
- [0029]** The connection of the communication module 23 to the warning devices 3, 31 is preferably carried out wirelessly, for example via Wi-fi, Bluetooth communication, but can also be carried out via suitable cables.
- [0030]** The control and communication unit 2 may optionally include interface devices such as a keyboard, a mouse, a monitor for local monitoring of system operation and management.
- [0031]** Optionally, the control and communication unit 2 may include a temperature control unit 25 which includes a heating body that heats the interior of the control and communication unit 2 when the temperature drops below 10 degrees Celsius, and a cooling body that cools the interior of the control and communication unit 2 when the temperature rises above 20 degrees Celsius.
- [0032]** The program module, which is implemented on the central processing unit 21 of the control and communication unit 2, is adapted for:
- entering, setting and changing the initial parameters, the initial parameters including at least the determination of the roadway zone 4, the determination of the entry line 5 and optionally the exit line 6 of the roadway zone 4 on the input image of the roadway zone 4 detected by the central camera 1, the determination of the direction of a vehicle's driving that triggers a wrong-way driving alarm, and the determination of the initial parameters for triggering the alarm, and
 - system control, wherein the control includes:
 - processing the recordings continuously transmitted by at least the central camera 1 and optionally the front 7 and rear 8 cameras, and storing these recordings in the internal memory 22, these recordings being deleted after a certain period of time, preferably every seven days;

- recognizing the wrong-way driving of the vehicle on the basis of the image transmitted from the central camera 1, and
- triggering the wrong-way driving alarm based on the detected wrong-way driving of the vehicle,
- wherein triggering the alarm involves transmitting a signal via the communication module 23 to trigger the transmission of recordings of the event triggering the alarm, at least from the central camera 1 and optionally from the front 7 and rear cameras 8, live, to the control centre of the competent authorities and simultaneous the transmission of a signal via the communication module 23 to at least the first warning device 3 which, on the basis of the signal, triggers appropriate warning signals to warn the wrong-way driving driver, and
- storing recordings of the event triggering the alarm, which were taken by the central camera 1 and optionally the front 7 and the rear cameras 8, from the internal memory 22 to an external memory for a subsequent analysis.

[0033] When the system further includes at least one second warning device 31, the triggering of the alarm further includes the simultaneous transmission of a signal to the second warning device 31, which triggers appropriate warning signals based on the signal to warn the driver who wishes to correctly drive into the exit that the exit is closed.

[0034] Entering, setting and changing the initial parameters can be done via a user interface locally (via interface devices) or remotely via a web connection.

[0035] In a preferred embodiment, determining the direction of travel of a vehicle that triggers a wrong-way driving alarm, and determining initial parameters of triggering an alarm are carried out by an arrow 10 that is drawn on the entry line 5 to the input image of the roadway zone 4 via a user interface, which is detected by the central camera 1 as shown in Figure 3. The orientation of a tip 11 of the arrow 10 determines the direction of travel of the alarm triggering wrong-way driving vehicle, a length L of the arrow 10 defines the initial parameters of alarm triggering. For example, an alarm is triggered if the system detects that the vehicle has first passed a tail 12 of the arrow 10 and then, within an appropriate time interval, the tip 11 of the arrow 10. If the system detects that the vehicle has first passed the tip 11 of the arrow 10 and within an appropriate time interval the tail 12 of the arrow 10, the alarm is not triggered.

[0036] Optionally, the system according to the invention may also include a mechanical floor barrier 9 which is shown in Figure 4. In a preferred embodiment, the floor barrier 9 includes a housing 91, in which at least two segments S are located, each of the segments S being

formed of an axle S1, on which blades S2 are fixed at regular intervals so that tips S3 of the blades S2, when the axle S1 is fixed to the housing 91, are facing in the wrong direction of driving. Each of the axles S1 is attached to the housing 91 via at least two supports 92. An individual axle S1 is attached to the support 92 via at least one spring element 93, so that rotation of the axle S1 is enabled and therewith the rotation of the blades S2 attached to the axle S1 is also enabled. The spring element 93 includes a rotation limiter 94 resting on the housing 91. The rotation limiter 94 allows the rotation of the axle S1 and consequently the rotation of the blades S2 attached to the axle S1 by a certain angle in one or another direction. In this way, the blades S2, when the vehicle is driving in the right direction, retract into the housing 91 and once the vehicle has passed the floor barrier 9 the blades S2 reassume their initial position. When the vehicle drives in the wrong direction, the blades S2 remain fixed in their original position, allowing the blades S2 to puncture the tyre.

[0037] In a preferred embodiment, an individual axle S1 is attached to the support 92 at its both ends via a spring element 93 with a stop 94.

[0038] The blade S2 is made of one piece and shaped so that the tip S3 is made with an angle α which is between 35 and 40 angular degrees. In a preferred embodiment, the distance between the blades S2 is five cm, the thickness of each blade S2 is two cm. Experiments have shown that such an arrangement and shape of the blades S2 enables safe puncture of the vehicle's tyre in such a way that the tyre does not deflate suddenly but gradually, so that the driver can stop safely even at speeds up to 50 km/h.

[0039] The housing 91 includes a cover 95 covering a hole in the roadway, in which the floor barrier 9 is arranged. The cover 95 has openings 96 arranged at the same distances as the distances between the blades S2, through which the blades S2 protrude.

[0040] The housing 91 also includes a rainwater drainage canal 97 so that water does not accumulate in the housing 91.

[0041] In a preferred embodiment, the floor barrier 9 is placed inside the roadway zone 4, behind the warning device 3 and in front of the exit line 6, in order to allow the central camera 1 to record the entire event, thereby further improving safety.

[0042] In a preferred embodiment, the system includes one central camera 1, one front camera 7, one rear camera 8, a control and communication unit 2, one first warning device 3, one second warning device 31 and a mechanical floor barrier 9.

System operation

[0043] When setting up the system at the motorway exit, the initial operating parameters are determined, for example the roadway zone 4, the entry line 5, direction of travel of the vehicle triggering the wrong direction alarm

and the position of the central camera 1 so that the viewing angle of the central camera 1 covers the entire roadway zone 4. The initial parameters of operation are defined in a way that on the input image of the roadway zone 4 detected by the central camera 1, a user interface module is used to draw in a roadway zone 4, an entry line 5, the direction of a vehicle's driving that triggers a wrong-way driving alarm, and the initial parameters for triggering the alarm. The direction of a vehicle's driving triggering a wrong-way driving alarm, and the initial parameters of alarm triggering are defined by drawing the arrow 10 on the entry line 5 as explained above.

[0044] When the system detects a wrong-way driving vehicle based on certain initial parameters, i. e. when the vehicle first passes the tail 12 of the arrow 10, and at the appropriate time interval the tip 11 of the arrow 10, a wrong-way driving alarm is triggered, wherein via a communication module 23 a corresponding signal is transmitted to all cameras 1, 7, 8 which start transmitting the live image to the control centre of the competent authorities, and whereby the live images are also stored in the external memory. At the same time, a corresponding signal is transmitted via the communication module 23 to both LED displays 3, 31, which trigger warning signals, thereby alerting the wrong-way driving driver and the driver wishing to correctly enter the exit that the exit is closed.

[0045] In the event that the wrong-way driving driver ignores the warning signal and continues driving, he drives over the floor barrier 9 which punctures the tyres, and the vehicle is physically stopped.

Claims

1. A system for preventing vehicles from driving in the wrong direction, **characterized by** including at least one central camera (1), a control and communication unit (2) and at least one first warning device (3), wherein the central camera (1) is connected to the control and communication unit (2) and positioned so that the viewing angle of the camera completely covers a predefined zone (4) of the roadway with a defined entry line (5), wherein the first warning device (3) is connected to the control and communication unit (2) and positioned to be visible to the driver when crossing the entry line (5), the control and communication unit (2) including

- at least one central processing unit (21) on which a programme module is implemented, for controlling the system in accordance with a pre-loaded computer programme,
- an internal memory (22) for recordings,
- a communication module (23) for wireless connection of the control and communication unit (2) with a surveillance central unit located at the competent authorities and for connection with

- at least the first warning device (3), and
- a power supply (24),

wherein the programme module is adapted for

- entering, setting and changing the initial parameters and for system control,

wherein the system control includes

- processing of recordings continuously transmitted by the central camera (1),
- storing these recordings in the internal memory (22),
- recognizing the wrong-way driving of the vehicle on the basis of the image transmitted from the central camera (1), and
- triggering the wrong-way driving alarm based on the detected wrong-way driving of the vehicle,

wherein the alarm triggering includes

- transmitting a signal via the communication module (23) to trigger the transmission of recordings of the event triggering the alarm, from the central camera (1), live, to the control centre of the competent authorities,
- simultaneous transmission of a signal via the communication module (23) to the first warning device (3) which, on the basis of the signal, triggers appropriate warning signals to warn the wrong-way driving driver, and
- storing recordings of the event triggering the alarm, which were taken by the central camera (1) from the internal memory 22 to an external memory for a subsequent analysis.

2. A system according to claim 1, **characterized by** further including at least one front camera (7) and at least one rear camera (8), both being connected with the control and communication unit (2) and arranged in a way that the front camera (7) records the front section of the vehicle and the driver's face, and the rear camera (8) records the rear section of the vehicle, wherein the control further includes the processing of data that are continuously transmitted by the front camera (7) and the rear camera (8), and storing of these data into the internal memory (22), and wherein the alarm triggering further includes transmitting a signal via the communication module (23) to trigger the transmission of recordings of the event triggering the alarm, from the front (7) and rear camera (8), live, to the control centre of the competent authorities, and storing recordings of the event triggering the alarm, which were taken by the front camera (7) and the rear camera (8), from the internal memory (22) to an external memory for a subsequent

analysis.

3. A system according to any preceding claims, **characterized by** further including at least one second warning device (31) connected with the communication module (23), wherein the triggering of the alarm further includes the transmission of a signal via the communication module (23) to the second warning device (31), which triggers warning signals based on the signal to warn the driver who wishes to correctly drive into the exit that the exit is closed. 5
4. A system according to any of preceding claims, **characterized in that** the connection of the communication module (23) with the surveillance central unit is carried out via an Internet modem with a SIM card. 10 15
5. A system according to any of preceding claims, **characterized in that** the connection of the communication module (23) to the warning devices (3, 31) is carried out wirelessly, for example via Wi-fi, Bluetooth communication. 20
6. A system according to any of preceding claims, **characterized in that** the initial parameters include at least the determination of the roadway zone (4), the determination of the entry line (5) of the roadway zone (4) on the input image of the roadway zone (4) detected by the central camera (1), the determination of the direction of a vehicle's driving that triggers a wrong-way driving alarm, and the determination of the initial parameters for triggering the alarm. 25 30
7. A system according to claim 6, **characterized in that** determining the direction of travel of a vehicle that triggers a wrong-way driving alarm, and determining initial parameters of triggering an alarm are carried out by an arrow (10) that is drawn via a user interface on the entry line (5) to the input image of the roadway zone (4), which is detected by the central camera (1), wherein the orientation of a tip (11) of the arrow (10) determines the direction of travel of the alarm triggering wrong-way driving vehicle, a length (L) of the arrow (10) defines the initial parameters of alarm triggering. 35 40 45
8. A system according to preceding claims, **characterized by** further including a mechanical floor barrier (9) that includes a housing (91), in which at least two segments (S) are located, each of the segments (S) being formed of an axle (S1), on which blades (S2) are fixed at regular intervals so that tips (S3) of the blades (S2), when the axle (S1) is fixed to the housing (91), are facing in the wrong direction of driving. 50 55
9. A system according to claim 8, **characterized in that** an individual axle (S1) is attached to the support (92) via at least one spring element (93), so that rotation

of the axle (S1) is enabled and therewith the rotation of the blades (S2) attached to the axle (S1) is also enabled, and wherein the spring element (93) includes a rotation limiter (94) that allows the rotation of the axle (S1) and consequently of the blades (S2) fixed on the axle (S1) by a certain angle to one or the other direction

10. A system according to claims 8 and 9, **characterized in that** the blade (S2) is made of one piece and shaped so that the tip (S3) is made with an angle (α) which is between 35 and 40 angular degrees, to allow safe puncturing of vehicle's tyres in a way that a tyre is not deflated immediately but gradually.

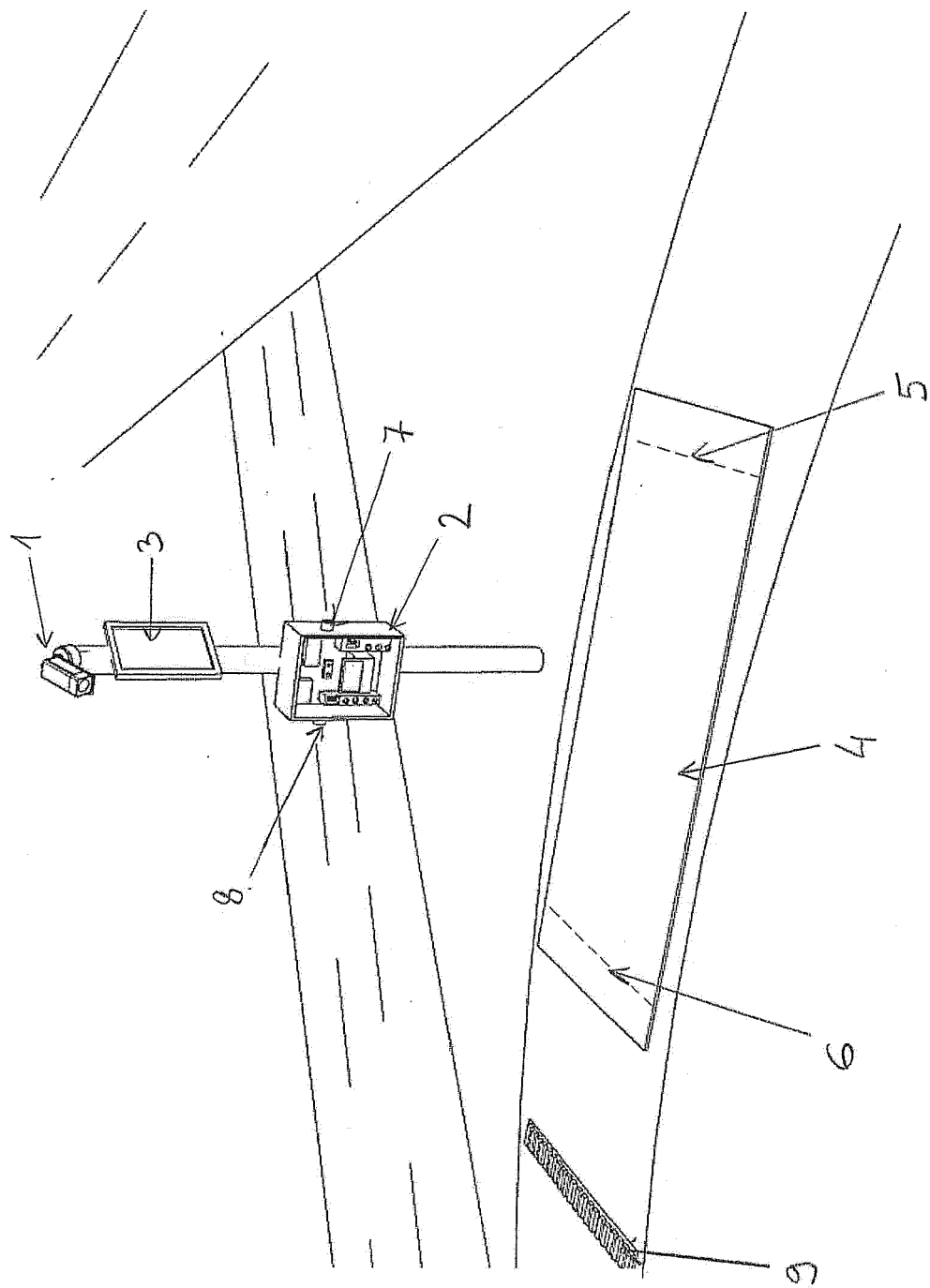


Fig. 1

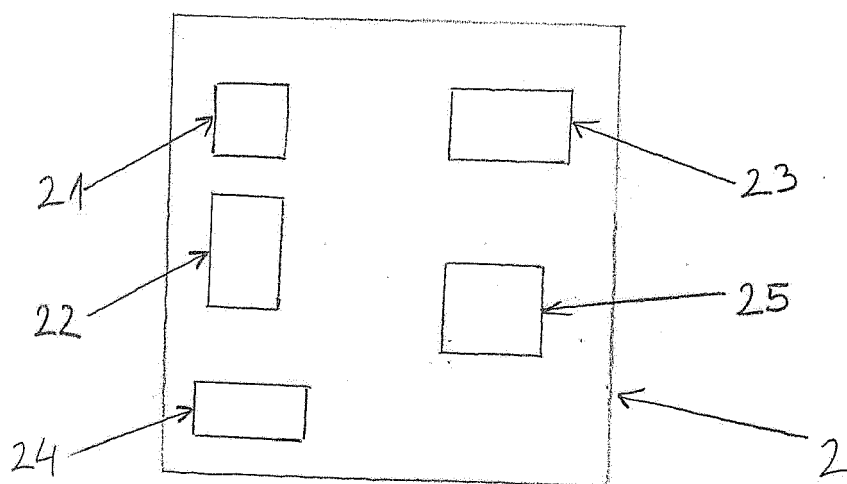


Fig. 2

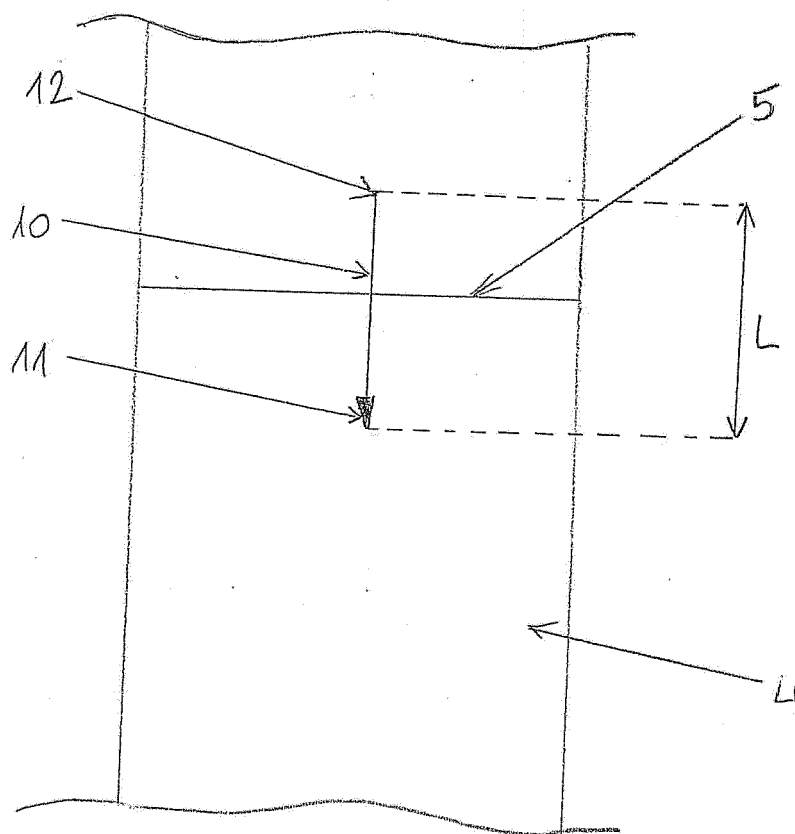


Fig. 3

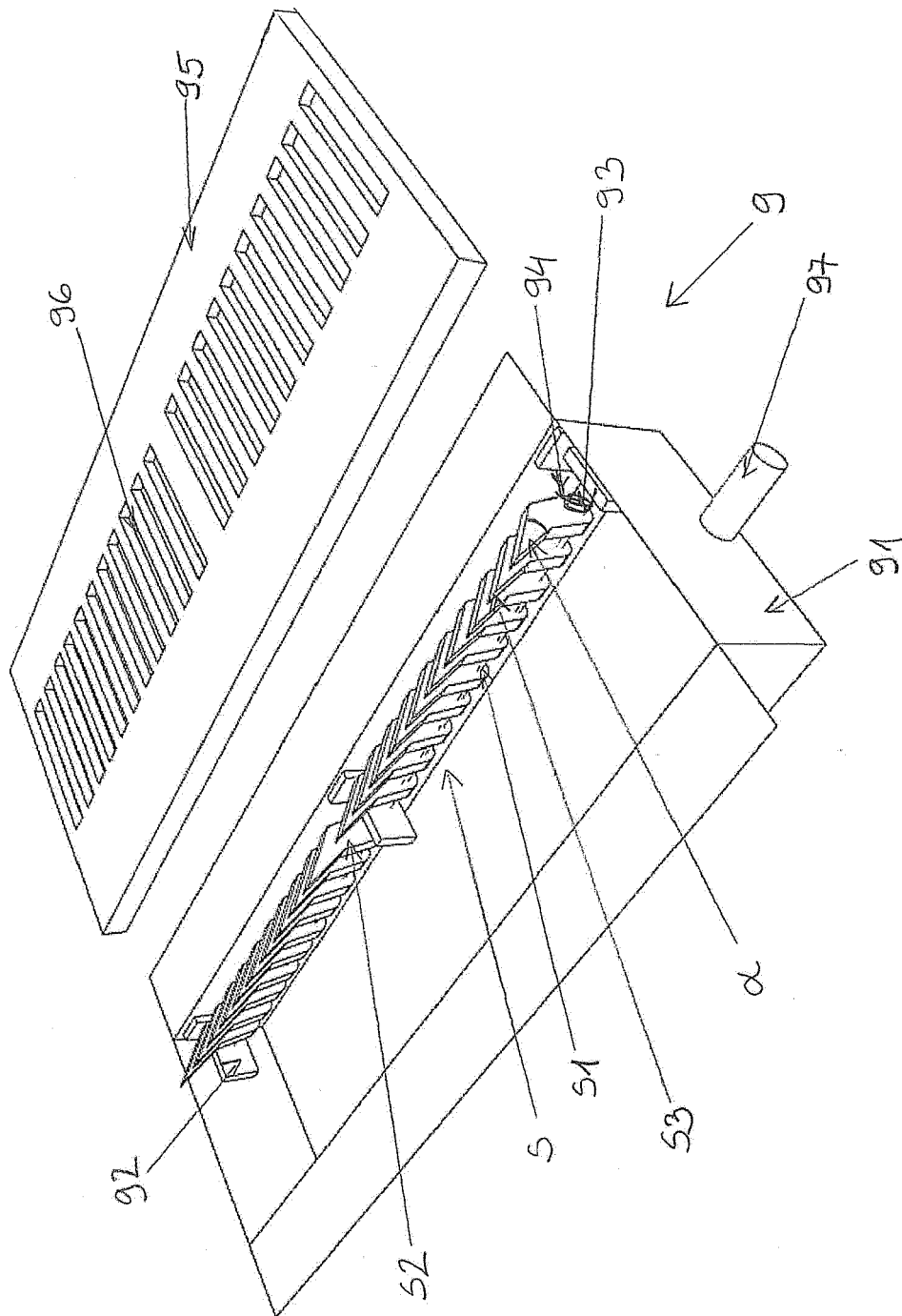


Fig. 4



EUROPEAN SEARCH REPORT

Application Number
EP 20 17 4297

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 10 407 853 B1 (DUNN PETER G [US] ET AL) 10 September 2019 (2019-09-10) * abstract; figures 1-13 * * column 1, line 43 - column 4, line 43 * * column 6, line 11 - column 9, line 28 *	1-10	INV. G08G1/056 G08G1/07 E01F13/10 E01F13/12 G08G1/01 G08G1/017
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X	US 2018/050693 A1 (AL DEEK HAITHAM [US] ET AL) 22 February 2018 (2018-02-22) * abstract; figures 1-7 * * paragraph [0025] - paragraph [0038] * * paragraphs [0042], [0047] *	1-5	
			TECHNICAL FIELDS SEARCHED (IPC)
			G08G E01F
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 30 September 2020	Examiner Fiorenzo Catalano, M
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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 20 17 4297

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30-09-2020

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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US 2015146001	A1	28-05-2015	NONE
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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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