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(54) **SYSTEM AND METHOD FOR ALERTING VEHICLES OR PEDESTRIANS ABOUT THE PRESENCE OF A RAILWAY VEHICLE ALONG A TRACK**

(57) System (100) and method (200) for alerting vehicles or pedestrians about the presence of an approaching railway vehicle (105) travelling along a track (115), wherein:

- a plurality of controlling devices (10) are positioned, spaced apart from each other, along the track (115);
- a plurality of controllable warning light signals (15) are positioned, spaced apart from each other, along at least one row (A) on one side of the track (115), each of the controlling devices (10) being operatively connected to and configured to control a predetermined number of

controllable warning light signals (15) positioned in sequence one after the other along the at least one row (A);
- a control system (30) is configured to output, while the vehicle (105) is travelling along the track (115), a command signal (Sc) indicative at least of the vehicle (105) under approach to the controlling device (10) positioned actually closest to the vehicle (105), and wherein, responsive to the command signal (Sc) received, said closest controlling device (10) is configured at least to trigger lighting up of one or more of the predetermined number of warning light signals (15) under its control.

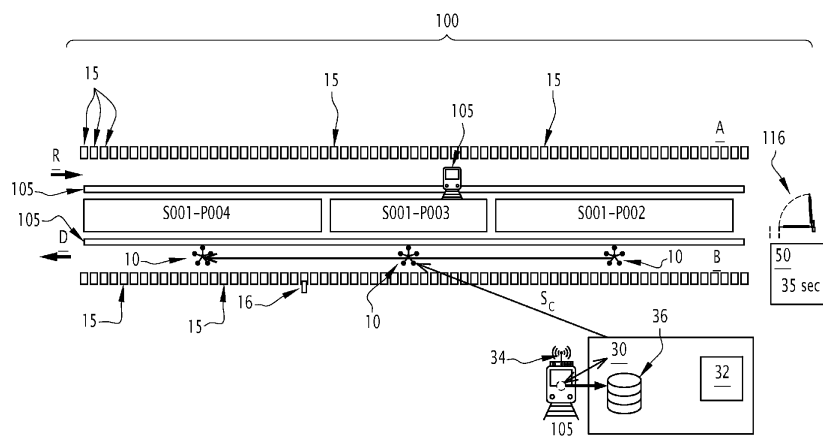


FIG.1

Description

[0001] The present invention concerns a system and a method for alerting vehicles or pedestrians about the presence of an approaching railway vehicle along a track.

[0002] The present invention is particularly suitable for being applied to trams travelling along tramways, for example in urban areas, and it will be described hereinafter by making particular reference to such application, without intending in any way to limit its possible application to other types of railway vehicles travelling along suitable tracks.

[0003] In the field of transportation, although trams are efficient means for urban commutation and are perceived as extremely safe transportation devices, they are rather vulnerable to traffic accidents with other vehicles, such as cars, cycles, motobikes, buses, other trams, or even with pedestrians.

[0004] Indeed, as reported by generally available statistics, accidents involving trams happen according to non-negligible rates and can occur for example when the tracks of a tramway cross other roads, and even more when the tracks of a tramway are installed in spaces shared with other roads.

[0005] The likelihood of accidents involving trams is further increased in case of low visibility, for example caused by the presence of fog or snow.

[0006] The main aim of the present invention is to face this issue and to provide a solution capable of at least reducing the possibility of accidents involving trams travelling along a tramway.

[0007] This aim is achieved by a system for alerting vehicles or pedestrians about the presence of an approaching railway vehicle travelling along a track, the system being characterized in that it comprises at least:

- a plurality of controlling devices which are positioned, spaced apart from each other, along the track;
- a plurality of controllable warning light signals which are positioned, spaced apart from each other, along at least one row on one side of the track, wherein each of the controlling devices is operatively connected to and is configured to control a predetermined number of controllable warning light signals positioned in sequence one after the other along the at least one row;
- a control system which is configured to output, while the vehicle is travelling along the track, a command signal indicative at least of the vehicle under approach to the controlling device positioned actually closest to the vehicle, and wherein, responsive to the command signal received, said closest controlling device is configured at least to trigger lighting up of one or more of the predetermined number of warning light signals under its control.

[0008] The above-mentioned aim of the present invention is also achieved by a method for alerting vehicles or pedestrians about the presence of an approaching railway vehicle travelling along a track, the method being characterized in that it comprises at least the following steps:

- (a): installing a plurality of controlling devices, spaced apart from each other, along the track;
- (b): installing a plurality of controllable warning light signals, spaced apart from each other, along at least one row on one side of the track;
- (c): connecting operatively each of the controlling devices to a predetermined number of controllable warning light signals which positioned in a continuous sequence one after the other along the at least one row, said predetermined number of controllable warning light signals being controlled by the controlling device to which they are operatively connected to;
- (d): outputting, via a control system, and while the railway vehicle is travelling along the track, a command signal indicative at least of the approaching railway vehicle to the controlling device positioned actually closest to the railway vehicle; and
- (e): triggering, by the closest controlling device, in response to the command signal received, at least lighting up of one of more of the predetermined number of warning light signals under its control.

[0009] Further characteristics and advantages will become apparent from the description of some preferred but not exclusive exemplary embodiments of a system and a method according to the present invention, illustrated only by way of non-limitative examples with the accompanying drawings, wherein:

figure 1 is a view schematically showing an exemplary embodiment of a system for alerting vehicles or pedestrians about the presence of an approaching railway vehicle travelling along a track, according to the invention, applied to a single-track tramway;

figures 2-4 are views schematically showing the alerting system according to the invention in different possible operative conditions;

figure 5 is a flow chart schematically illustrating a method for alerting other vehicles or pedestrians about the presence of an approaching railway vehicle travelling along a track, according to the present invention.

[0010] It should be noted that in the detailed description that follows, identical or similar components, either from a structural and/or functional point of view, may have the same reference numerals, regardless of whether they are shown in different embodiments of the present disclosure; it should also be noted that in order to clearly and concisely describe the present disclosure, the drawings may not necessarily be to scale and certain features of the disclosure may be shown in somewhat schematic form.

[0011] Further, when the term "adapted" or "arranged" or "configured" or "shaped", or a similar term is used herein while referring to any component as a whole, or to any part of a component, or to a combination of components, it has to be understood that it means and encompasses correspondingly either the structure, and/or the configuration and/or the form and/or the positioning.

[0012] Figures 1-4 illustrate schematically a system 100 for alerting vehicles or pedestrians about the presence of an approaching railway vehicle, for example a tram 105, travelling along a track, namely in the example illustrated a tramway track 115, e.g. applied to a single track tramway as depicted in figures 1 and 3, or to a double track tramway as represented in figures 2 and 4.

[0013] The alerting system 100 according to the invention comprises at least a plurality of controlling devices 10 which are positioned, spaced apart from each other, along the track 115, and comprising each a processor or processor-based device and a transceiver.

[0014] Each controlling device 10 is for example in operative communication with at least one adjacent controlling device 10 and is assigned to a respective portion of the tramway 115; for example, in figures 1-3 there is represented a portion of the tramway 115 comprising three segments, e.g. segments with ID S001-P004, S001-P003 and S001-P002 (see figures 1 and 2), and along each segment there is installed a corresponding controlling device 10.

[0015] In particular, with respect to the whole extension of the tramway 115 from a starting point to a terminus, the plurality of controlling devices 10 comprises an initial controlling device positioned at the start of the tramway 115, a final controlling device positioned at the end of the tramway 115, and a plurality of intermediate controlling devices positioned in sequence along the tramway 115 between the initial controlling device and the final controlling device.

[0016] Usefully, each of the plurality of intermediate controlling devices is for example operatively connected to at least one controlling device 10 positioned immediately upward (or succeeding) and to at least one controlling device 10 positioned immediately backward (or preceding) along the tramway 115; clearly the initial controlling device 10 is operatively connected only with the controlling device 10 positioned immediately upward to it, and the final controlling device 10 is operatively connected only with the controlling device 10 positioned immediately backward to it.

[0017] The terms upward and backward have to be understood with reference to the travelling direction of a tram 105 along the tramway 115, indicated in figure 1 by the arrow D; hence the upward controlling device 10 is the next device 10 to be encountered by the tram 105 during its travel, while the backward controlling device is the device just previously passed by.

[0018] Clearly, if a track of the tramway 115 can be travelled also in the reverse direction, indicated by the arrow R in figure 1, then the first controlling device 10 in the direction D becomes the final controlling device in the reverse direction R, the final controlling device 10 in the direction D becomes the initial controlling device in the reverse direction R.

[0019] If a portion of the track diverges into two branches of the tramway 115, or if two branches of the tramway 115 converge into a single portion, the controlling device(s) 10 of the segments at the bifurcation can be connected to more than one preceding/succeeding controlling devices 10.

[0020] Advantageously, the alerting system 100 comprises also at least a plurality of controllable warning light signals, schematically indicated in the attached figures by the reference number 15 and which are positioned, spaced apart from each other, along at least one row A on one side of the tramway 115.

[0021] In particular, each of the controlling devices 10 is operatively connected to and is configured to control a predetermined number of controllable warning light signals 15 which are positioned in a continuous sequence one after the other along the at least one row A.

[0022] According to a possible embodiment, as illustrated in the figures 1-4, the controllable warning light signals 15 are preferably positioned, spaced apart from each other, along two rows, namely a first row A positioned on one external side of the tramway 115 and along a second row B positioned on the other external side of the tramway 115.

[0023] According to this embodiment, each controlling device 10 is operatively connected to and is configured to control a predetermined number of controllable warning light signals 15, namely the controllable warning light signals 15 along both the rows A and B that are positioned in the segment of the tramway 115 where the relevant controlling device 10 is installed.

[0024] According to a possible embodiment, each controlling device 10 is connected to the controllable warning light signals 15 under its control via a cabled connection; also the connection among the controlling devices can be realized via cables.

[0025] Usefully, all the controlling devices 10 and the warning light signals 15 can be supplied by the same power line supplying the tramway 115, e.g. a third rail, schematically represented in figure 4 by the reference number 117.

[0026] In one possible embodiment of the alerting system 100 according to the invention, each of the plurality of

controllable warning light signals 15 comprises a LED road stud.

[0027] In particular, each LED road stud conveniently comprises a photodetector, indicated in figure 1 by the reference number 16 only for one stud 15 just for ease of illustration.

[0028] Accordingly, each controlling device 10 is configured to check, e.g. to sample, the output of the photodetector 16 of each of the LED road stud 15 under its control, and if a failure status for a LED road stud is detected, to output a warning signal indicative of the LED road stud 15 under failure identified.

[0029] As those skilled in the art would easily appreciate, the LED road studs 15 can be of any suitable type commercially available, provided with the necessary circuitry and/or software suitably programmable for performing the functionalities required within the frame of the present invention, wherein the LED is installed inside the stud in order to be mechanically protected.

[0030] In practice, in the alerting system 100 according to the present invention, each controlling device 10 is assigned to a segment of the tramway 115 and forms a "parent node" controlling a plurality of children nodes, namely all LED road studs 15 which are installed within the same segment.

[0031] In the examples illustrated in figures 1-4, the LED road studs 15 are mounted along the tramway 115, for example a few centimeters away from the track along the two rows A and B, and each LED road stud 15 is spaced from the adjacent one(s) by a distance of about 0.5m.

[0032] Each pair of LED road studs 15 can be assigned with an identification number; for instance, odd numbers can be used in one row and even numbers in the other row; hence, the identification numbers 1 and 2 would represent the two LED road studs 15 installed along the relevant segment at the same position but on the two respective rows A and B, the identification number 3 would be the second LED road stud 15 immediately following the first LED road stud 1 on the row A, and the identification number 4 would be the second LED road stud 15 immediately following the first LED road stud 2 on the row B, with the couple of LED road studs identified as 3 and 4 which occupy the same position in the relevant segment, on the two respective rows A and B. The same applies to all other couples of LED road studs 15 installed in the same segment of the tramway 115 up to the last couples of LED road studs 15, identified in the example illustrated by the ID numbers "43" and "44".

[0033] In the example illustrated in figures 1, 2 and 4, there are represented three segments, each having a length of 11m and therefore comprising a total of forty-four LED road studs 15, formed by twenty-two couples.

[0034] The alerting system 100 according to the present invention further comprises at least a control system, schematically indicated in figure 1 by the reference number 30, which is configured to output, preferably in real time and while the tram 105 is travelling along the tramway 115, a command signal S_c to the controlling device 10 positioned actually closest to the tram 105, namely the controlling device 10 immediately ahead of the tram 105 along the tramway 115 in the actual travelling direction D or R.

[0035] According to a possible embodiment, the control system 30 is preferably positioned on board of the tram 105.

[0036] In particular, the control system 30 comprises an on-board communication device 34 which is configured to communicate, with each controlling device 10, in a wireless manner and using a very short distance communication range, for example covering a distance of a very few meters or even less.

[0037] The command signal S_c is configured to carry at least information indicative of the fact that the tram 105 is approaching a segment, e.g. the segment S001-P003.

[0038] In particular, responsive to the command signal S_c received, such closest controlling device 10 immediately ahead of the tram 105 along the tramway 115 is configured to decode the received message and at least to trigger lighting up of one or more of the predetermined number of warning light signals 15 under its direct control.

[0039] The command signal transmitted S_c can be properly encrypted if desired or necessary; further, If a track can be travelled in both directions, then the command signal S_c is configured to carry at also the information relative to the direction of the tram 105 and can be properly displayed along the tramway 115, for example by lighting up any display on the side of the tracks or by lighting up the LEDs in a manner indicating such direction, i.e. the LEDs can flicker in sequence along the specific travelling direction.

[0040] In one possible embodiment of the alerting system 100, the control system 30 comprises a processing unit 32 configured to dynamically calculate, for example in real time while the tram 105 is travelling along the tramway 115, and based on one or more pre-selected criteria, a desired number of warning light signals 15 to be lit, and to output a command signal S_c to the closest controlling device 10 configured to carry out also data indicative of the calculated desired number of warning light signals 15 to be lit.

[0041] In particular, the preselected criteria can comprise one or more of the following: human reaction times relative to the tram actual speed; the response time of the system relative to the speed of the tram, i.e. the time interval between the control system 30 outputs the command signal S_c and the instant at which the LEDs are lit by the relevant controlling device 10; the distance/time frequency at which the control system outputs the command signals S_c ; a desired additional buffer distance/time for increasing safety.

[0042] If the tramway is not dedicated exclusively to the trams but it is shared with other vehicles, then the preselected criteria can comprise also one or more of: the braking distance of a tram relative to its speed, which can be calculated

in real time on-board by the processing unit 32, or it can be stored in the control system 30 as a 'lookup table' linking the various speeds of a tram versus the corresponding braking distances; reaction times of drivers of other road vehicles and braking distance of such vehicles versus their speed; braking distance of road vehicles from a level crossing, which is based on average road speed limits, which criteria can be used both when the tramway is in areas shared with road vehicles and when is dedicated to trams.

[0043] Accordingly, each controlling device 10 is configured to propagate the command signal Sc received from the control system 30 to either the controlling device 10 positioned immediately upward and/or to the controlling device 10 positioned immediately backward with respect to it, based on the total number of warning light signals 15 to be lit.

[0044] Further, the control system 30 comprises at least one database, schematically represented in figure 1 by the reference number 36, which stores data selected from the group comprising data related but not limiting to: the type of tracks 115, namely whether the track is specifically dedicated only to railway vehicles, such as trams and thus flagged as "1", or it is shared for example with other types of vehicles and thus flagged as "0"; lists of track segments or portions composing the track 115; identification data and length for each track segment or portion forming the tramway 115; number of controllable warning light signals 15 positioned along each segment of the track 115; identification data for each upcoming segment in the travelling direction D along the track 115 and for each upcoming segment in the reverse direction R along the track 115; identification data and length for each level crossing present along the track 115, distance of the two ends of each level crossing from a reference controllable warning light signal 15.

[0045] As those skilled in the art would appreciate, the database 36 can be further populated with other data, and/or the data can be stored in two or more separate databases.

[0046] In case the relevant tramway 115 crosses with a level crossings 116, then the alerting system conveniently comprises, for each level crossing present along the tramway 115, at least one additional display, schematically represented in figure 1 by the reference number 50, which is configured to display, for example under the control of the on-board control system 30, each information relative to one or more actual working parameters of the tram 105 approaching the corresponding level crossing, such as for example the incremental time for the arrival of the tram 105 at the junction. The same information can be displayed also at additional LED signals/displays placed for example at the maximum braking distance of road vehicles from the junction with the level crossing.

[0047] In one possible embodiment, in order to further improves the overall safety, the alerting system 100 comprises a first display 38 positioned at the front end of the tram 105 and a second display 40 positioned at the rear end the tram 105, as illustrated in figure 3; the first and second displays 38 and 40 are configured to display, for example under the control of the on-board control system 30, each information indicative of one or more actual working parameters of the tram 105, such as for example its current speed.

[0048] Figure 5 illustrates a method 200 for alerting vehicles or pedestrians about the presence of an approaching railway vehicle, such as a tram 105 travelling along a track, such as a tramway 115, which can be carried out for example in connection with the system 100.

[0049] As illustrated, the method 200 comprises at least the following steps:

- 210: installing a plurality of controlling devices 10 spaced apart from each other, along the tramway 115
- 220: installing a plurality of controllable warning light signals 15, spaced apart from each other, along at least one row A, on one side of the track 115;
- 225: connecting operatively each of the controlling devices 10 to a predetermined number of controllable warning light signals 15 which are positioned in a continuous sequence one after the other along the at least one row A, said predetermined number of controllable warning light signals 15 being controlled by the controlling device 10 to which they are operatively connected to;
- 230: outputting, via a control system 30, which is positioned for example on board of the railway vehicle 105, e.g. the tram, while the tram 105 is travelling along the tramway 115, a command signal Sc indicative at least of the approaching tram 105 to the controlling device 10 positioned actually closest to the tram 105; and
- 235: triggering, by the closest controlling device 10, in response to the command signal Sc received, at least lighting up of one of more of the predetermined number of warning light signals 15 under its control.

[0050] In particular, the step 230 of outputting, comprises calculating, while for example the tram 105 is travelling along the tramway 115 preferably in real time, and based on one or more pre-selected criteria, namely those previously indicated, a desired number of warning light signals 15 to be lit, and generating a command signal Sc to be outputted to the closest controlling device 10 which is configured to carry out also data indicative of the calculated desired number of warning light signals 15 to be lit.

[0051] According to one embodiment, as previously described with reference to the system 100, the method 200 comprises the step 215 of putting each controlling device 10 in operative communication with at least one adjacent controlling device 10.

[0052] For example, as illustrated in figure 5, the step 215 can be carried put between the above described steps 210

and 220.

[0053] Accordingly, the method 200 comprises the further step 240 of propagating, by each controlling device 10, the command signal S_c received from the control system 30, to at least one adjacent controlling device 10.

[0054] In particular, according to one possible example, the step 215 comprises putting each controlling device 10 in operative communication with at least one controlling device 10 positioned immediately upward and to at least one controlling device 10 positioned immediately backward, and the step 240 comprises propagating, by each of the intermediate controlling device 10, the command signal S_c received from the control system 30, to the respective controlling device 10 positioned immediately upward and/or the respective controlling device 10 positioned immediately backward.

[0055] Yet according to a possible embodiment, the method 200 further comprises the steps of:

- 245 monitoring, by means of each controlling device 10, the correct functioning of each of the warning light signals 15 under its respective control; and
- 250: if a failure status for a light warning signal 15 is detected, outputting a warning signal indicative of the light warning signal 15 under failure identified.

[0056] In practice, when a tram 105 is travelling for example along the direction D, the control system 30 issues a command signal S_c which is received by the closest controlling device 10, e.g. the one immediately ahead of the tram itself. For instance, in the example illustrated where for each segment there are installed twenty-two couples of LED road studs 15 connected to and controlled by a controlling device 10 a signal with twenty two bits of data is sufficient for the relevant controlling device 10 to power on and therefore light up all forty four LEDs. For each LED, only one visible aspect is sufficient, for example the colour RED lit.

[0057] In particular, if the tramway 115 is dedicated exclusively to trams, a related flag in the database 36 is set as "1". Then, the processing unit 32 can calculate the number of LEDs to be powered on dynamically on-board based on the previously indicated criteria, namely:

- (i) number of LEDs per each row to be lit due to human reaction time of road users: for a typical speed of a tram of 20 km/h i.e. 5.5 m/s, and a typical human reaction time of 1.5 sec, the distance travelled is about 8.25 m, thus involving about eighteen LEDs if spaced of 0.5 m;
- (ii) response time of the system relative to the speed of the tram: it can be assumed as 1 sec, during which the distance travelled would be about 5.5 m thus involving about eleven LEDs to be lit on a row;
- (iii) the distance/time frequency at which the control system outputs the command signals S_c : for example, if it is assumed that the control system 30 outputs the command signal S_c at the fixed distance frequency of 3 m, then six LEDs would be included to be lit on a row;
- (iv) additional buffer distance/time for increasing safety: for example with a buffer distance of 2.5 m, five LEDs per row would be involved to be lit.

[0058] Hence, according to this example, a total number of forty LEDs should be lit on a row.

[0059] Accordingly, as shown in figure 2, if the tram 105 is assumed to be at 6th LED of the segment S001-P002, sixteen couples of LEDs in the current segment S001-P002 and remaining twenty-four couples of LEDs in the following segments are lit, namely all LEDs in segment S001-P003 and two couples in segment S001-P004; the LEDs lit are represented by boxes 15 fully filled in (dark boxes), while those switched OFF are represented by empty boxes 15.

[0060] The signal command S_c can be written as per table below:

32 bits	22 bits (Common - Both Directions- 1.. 43/2..44 of LEDs)
Name	1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43
S001-P002	0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
S001-P003	1 1
S001-P004	1 1 0

[0061] As shown in figure 3, preferably the segments around the tram 105 can be also highlighted with LEDs lit up; accordingly, if the total length of the tram 105 is for example 33 m, the entire tram can cover sixty-six LEDs on one row. Hence, the LEDs to be lit are distributed, per each row, as follows: six LEDs in the current segment S001-P002, plus twenty-two LEDs in segment S001-P001, plus twenty-two LEDs in segment S00Z-P005, plus sixteen LEDs in segment S00Z-P004; the LEDs lit are represented by boxes 15 fully filled in (dark boxes), while those switched OFF are represented by empty boxes 15.

[0062] The signal command Sc is written as per table below:

Name	13 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43
S001-P002	1 1 1 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
S001-P001	1 1
S00Z-PM5	1 1
S00Z-P004	0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

[0063] Since the transmission is substantially instantaneous at the segment parent node 10, the control system 30 of the tram 105 calculates the number of LEDs to be powered on in advance for both normal and reverse paths D and R; for this, the database 36 is maintained and used onboard of each tram.

[0064] If the tramway 115 is shared with other vehicles, the related flag in the database 36 is set as "0". In this case, the warning LEDs to be lit additionally, with respect to those illustrated with reference to figures 2 and 3, are illustrated in figure 4, and calculated taking into account also the following:

(v) the braking distance of a tram relative to its speed: the number of LEDs to be lit for preceding vehicles is based on the "tram braking distance" and in case of congestion on a shared route, the tram driver can also adjust the tram speed based on the traffic condition so as to not to exceed LED lighting beyond the preceding vehicles. For a typical speed of a tram of 20 km/h i.e. 5.5 m/s, and a typical deceleration rate of 1.3 m/sec², the braking distance is about 23 m, thus involving about forty-six LEDs if spaced of 0,5m. The number of LEDs equivalent to the tram braking distance is added to the preceding segments in addition to the number of LEDs lit as shown in figure 2.

(vi) reaction times of drivers of other road vehicles and braking distance of such vehicles versus their speed: these are the warning LEDs to be lit for the following vehicles not to cross these the lit LEDs so as to avoid the accidents with the tram 105. For example, if the maximum allowed speed for the following road vehicle is 20 km/h, then the reaction time of a driver is about 1.5 sec. The braking time at 20 km/h can be calculated as 3 sec. Similarly, the braking distance at 20 km/h can be also used.

[0065] Hence, the distance to cross in total in 4.5 sec, is about 24.75 m which would correspond to fifty LEDs to be lit on a row.

[0066] Therefore, fifty LEDs from the edge of the tram 105 in succeeding segments need to be powered on as shown in figure 4, where the LEDs lit are represented by boxes 15 fully filled in (dark boxes).

[0067] The signal command Sc is written as per table below:

32 bits	22 bits (Common - Both Directions- 1.. 43/2..44 of LEDs)
Name	1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43
S00Z-P004	1 1 1 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
S00Z-P003	1 1
S00Z-P002	1 1

[0068] Whenever there is a level crossing 116 along the tramway 115, the visibility of road vehicles from the tram or vice versa is often poor since the junction of roads and tramways are often perpendicular to each other. Hence, to avoid the tram-vehicle accident at these junctions, it is usefully required to consider the braking distance of the road vehicle, which is based on average road vehicle speed or limits. The number of LEDs equivalent to the vehicle braking distance is added in addition to the number of LEDs lit as shown in figure 2.

[0069] Further, in order to assist drivers of road vehicles, in addition to LED lighting, at the level crossing, the information on incremental time for the arrival of the tram at the junction is displayed using LED signals/displays 50 at both ends and at few meters from LED lighting. The same displays/signals are also kept at the maximum allowed road vehicle braking distance from the junction.

[0070] Based on the above details, the tram has to send LED powering ON/OFF commands to its current segment. As it is possible to have normal or reverse tracks/segments in a specific direction, it is useful to include this information in the command. As the current segment only can receive the command from the tram 105 (due to the short communication link), it has to forward the same to preceding/succeeding segments appropriately, using for example the wired connection.

Hence, the command format is designed as:

Segment ID	LED Output to be set	Direction	Track Type	Segment Type	Segment Index in Preceding/Succeeding segments
32 bits	22 bits	1 bit (0 -> Station A to B, 1 -> Station B to A)	1 bit (0 -> Normal, 1 -> Reverse)	2 bits (00 -> Current, 01 -> Preceding, 10 -> Succeeding)	4 bits (0000 -> current, 1 to 15 -> Preceding/Succeeding segment)

[0071] Upon receiving these commands, the relevant controlling device 10 segregates the messages based on the 'segment type' and 'track type' and forwards it to the next immediately available preceding/succeeding controlling device 10. Each preceding/succeeding controlling devices 10 processes the forwarded command and further forwards it, to the extent necessary, to its preceding/succeeding controlling devices after extraction of its command. This forwarding repeats till the 'segment Index in preceding/succeeding segments' is '1111' as shown in the table below. For example, for the combined situations illustrated in figures 2 and 3, the actual command will be as per the below table:

Segment ID	LED Output to be set	Direction	Track Type	Segment Type	Segment Index in Preceding/Succeeding segments
S001-P002 (Current Segment)	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	0 (Station-A to B)	0 (Normal)	00 (current)	0000 (Current)
S001-P003 (Preceding Segment-1)	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	0 (Station-A to B)	0 (Normal)	01 (Preceding)	1110 (First preceding segment)
S001-P004 (Preceding Segment-2)	1 1 0	0 (Station-A to B)	0 (Normal)	01 (Preceding)	1111 (Second/Last preceding segment)
S001-P001 (Succeeding Segment-1)	1 1	0 (Station-A to B)	0 (Normal)	10 (Succeeding)	1101 (First Succeeding segment)
S00Z-P005 (Succeeding Segment-2)	1 1	0 (Station-A to B)	0 (Normal)	10 (Succeeding)	1110 (Second Succeeding segment)
S00Z-P004 (Succeeding Segment-3)	0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	0 (Station-A to B)	0 (Normal)	10 (Succeeding)	1111 (Third/ Last Succeeding segment)

[0072] When the relevant controlling device 10 commands the LEDs with power ON/OFF, it has to ensure that the desired status for each led is SET appropriately. For this, as previously described, each LED road stud 15 is integrated with a photodetector 16. The controlling device 10 samples the output of the photodetector 16 as the readback signal and checks it against the SET input. If both input and output statuses are the same, it is confirmed that the LED is working as expected. If there is a deviation, it is reported back to the tram 105 for further analysis. For this, each controlling device 10 forwards the message to the next immediate preceding/succeeding controlling device 10 as the "LED error message". This forwarding will continue until it reaches for example the controlling device 10 at a line station. The controlling device which belongs to the line station finally communicates the LED error message, i.e. the segment ID, the LED number, row A or row B, error message number (to indicate faulty LEDs), et cetera, to the tram 105 or directly to a tramway control centre.

[0073] Hence, it is evident from the foregoing description that the system 100 and method 200 according to the present invention allow achieving the intended aim since they alert in advance other vehicles and pedestrians about the presence of an approaching railway vehicle, such as a tram, thus reducing the possibility of accidents. Indeed, the solution according to the invention enables vehicles/pedestrians to move away from the path or to follow with reduced speed whenever LED road studs 15 are lit. Also, drivers of the railway vehicles are helped in locating road vehicles/pedestrians within their visible distance with reference to the LED lighting. This enables for example the driver of the tram to adjust the

tram speed according to the road-tramway traffic condition in case of slowly moving traffic by seeing LED lighting.

[0074] The system 100 and method 200 thus conceived are susceptible of modifications and variations, all of which are within the scope of the inventive concept as defined in particular by the appended claims; for example, the processing unit 32 and/or the processor of the controlling devices 10 can be constituted by, or comprise, any suitable processor-based device, e.g. a processor of a type commercially available, suitably programmed and provided to the extent necessary with circuitry, in order to perform the innovative functionalities devised for the system 100 and method 200 according to the present invention; the distance between LEDs can be modified, and/or the number of LEDs per each segment can be different; the steps of the method can be executed in a different suitable sequence with respect to the exemplary order described with reference to figure 5.

[0075] All the details may furthermore be replaced with technically equivalent elements.

Claims

1. System (100) for alerting vehicles or pedestrians about the presence of an approaching railway vehicle (105) travelling along a track (115), the system being **characterized in that** it comprises at least:
 - a plurality of controlling devices (10) which are positioned, spaced apart from each other, along the track (115);
 - a plurality of controllable warning light signals (15) which are positioned, spaced apart from each other, along at least one row (A) on one side of the track (115), wherein each of the controlling devices (10) is operatively connected to and is configured to control a predetermined number of controllable warning light signals (15) positioned in sequence one after the other along the at least one row (A);
 - a control system (30) which is configured to output, while the vehicle (105) is travelling along the track (115), a command signal (Sc) indicative at least of the vehicle (105) under approach to the controlling device (10) positioned actually closest to the vehicle (105), and wherein, responsive to the command signal (Sc) received, said closest controlling device (10) is configured at least to trigger lighting up of one or more of the predetermined number of warning light signals (15) under its control.
2. System (100) as in claim 1, wherein the control system (30) comprises a processing unit (32) configured to dynamically calculate, in real time while the railway vehicle (105) is travelling along the track (115), and based on one or more pre-selected criteria, a desired number of warning light signals (15) to be lit, a command signal (Sc) outputted to the closest controlling device (10) being configured to carry out data indicative of the calculated desired number of warning light signals (15) to be lit.
3. System (100) as in claim 1 or 2, wherein the plurality of controlling devices (10) comprises an initial controlling device positioned at the start of the track (115), a final controlling device positioned at the end of the track (115), and a plurality of intermediate controlling devices positioned in sequence along the track (115) between the initial controlling device and the final controlling device, and wherein each of the controlling devices is in operative communication with at least one adjacent controlling device and is adapted to propagate the command signal (Sc) received from the control system (30) to the said adjacent controlling device.
4. System (100) as in any one of the preceding claims, wherein each of the plurality of controllable warning light signals (15) comprises a LED road stud.
5. System (100) as in claim 4, wherein each LED road stud (15) comprises a photodetector (16), and wherein each controlling device (10) is configured to check the output of the photodetector of each of the LED road stud (15) under its control, and if a failure status for a LED road stud is detected, to output a warning signal indicative of the LED road stud under failure identified.
6. System (100) as in any one of the preceding claims, wherein the control system (30) is positioned on board of the railway vehicle (105) and comprises an on-board communication device (34) which is configured to communicate with each controlling device (10) using a very short distance communication range.
7. System (100) as in any one of the preceding claims, wherein it further comprises, for each level crossing present along the track (115), at least one additional display (50) which is configured to display, under the control of said control system (30) each information relative of one or more actual working parameters of the railway vehicle (105) approaching the corresponding level crossing.

8. System (100) as in any one of the preceding claims, wherein it further comprises a first display (38) positioned at the front end of the railway vehicle (105) and a second display (40) positioned at the rear end the railway vehicle (105), the first and second displays (38, 40) being configured to display, under the control of said control system (30) each information indicative of one or more actual working parameters of the railway vehicle (105).

9. System (100) as in any one of the preceding claims, wherein the control system (30) comprises at least one database (36) comprising data selected from the group comprising data related to the type of track (115), lists of track segments composing the track (115), identification data and length for each track segment forming the track (115), number of controllable warning light signals (15) positioned along each segment of the track (115), identification data for each upcoming segment in the travelling direction along the track (115) and for each upcoming segment in the reverse direction along the track (115), identification data and length for each level crossing present along the track (115), distance of the two ends of each level crossing from a reference controllable warning light signal (15).

10. A method (200) for alerting vehicles or pedestrians about the presence of an approaching railway vehicle (105) travelling along a track (115), the method being **characterized in that** it comprises at least the following steps:

- (210): installing a plurality of controlling devices (10), spaced apart from each other, along the track (115);
- (220): installing a plurality of controllable warning light signals (15), spaced apart from each other, along at least one row (A) on one side of the track (115);
- (225): connecting operatively each of the controlling devices (10) to a predetermined number of controllable warning light signals (15) which positioned in a continuous sequence one after the other along the at least one row (A), said predetermined number of controllable warning light signals (15) being controlled by the controlling device (10) to which they are operatively connected to;
- (230): outputting, via a control system (30), and while the railway vehicle (105) is travelling along the track (115), a command signal (Sc) indicative at least of the approaching railway vehicle (105) to the controlling device (10) positioned actually closest to the railway vehicle (105); and
- (235): triggering, by the closest controlling device (10), in response to the command signal (Sc) received, at least lighting up of one of more of the predetermined number of warning light signals (15) under its control.

11. A method (200) as in claim 10, wherein said step (230) of outputting, comprises calculating, while the railway vehicle (105) is travelling along the track (115), and based on one or more pre-selected criteria, a desired number of warning light signals (15) to be lit, and generating a command signal (Sc) to be outputted to the closest controlling device (10) configured to carry out data indicative of the calculated desired number of warning light signals (15) to be lit.

12. Method (200) as in claim 10 or 11, wherein the plurality of controlling devices (10) comprises, with respect to the track (115), an initial controlling device positioned at the start of the track (115), a final controlling device positioned at the end of the track (115), and a plurality of intermediate controlling devices positioned in sequence along the track (115) between the initial controlling device and the final controlling device, wherein the method (200) comprises the step (215) of putting each of the controlling devices in operative communication with at least one adjacent controlling device, and the further step (240) of propagating, by each of the controlling device (10), the command signal (Sc) received from the control system (30) to an adjacent controlling device.

13. Method (200) as in any one of claims 10 to 12, wherein it further comprises the steps of :

- (245) monitoring, by means of each controlling device (10), the correct functioning of each of the light warning signals (15) under its respective control; and
- (250): if a failure status for a light warning signal (15) is detected, outputting a warning signal indicative of the light warning signal (15) under failure identified.

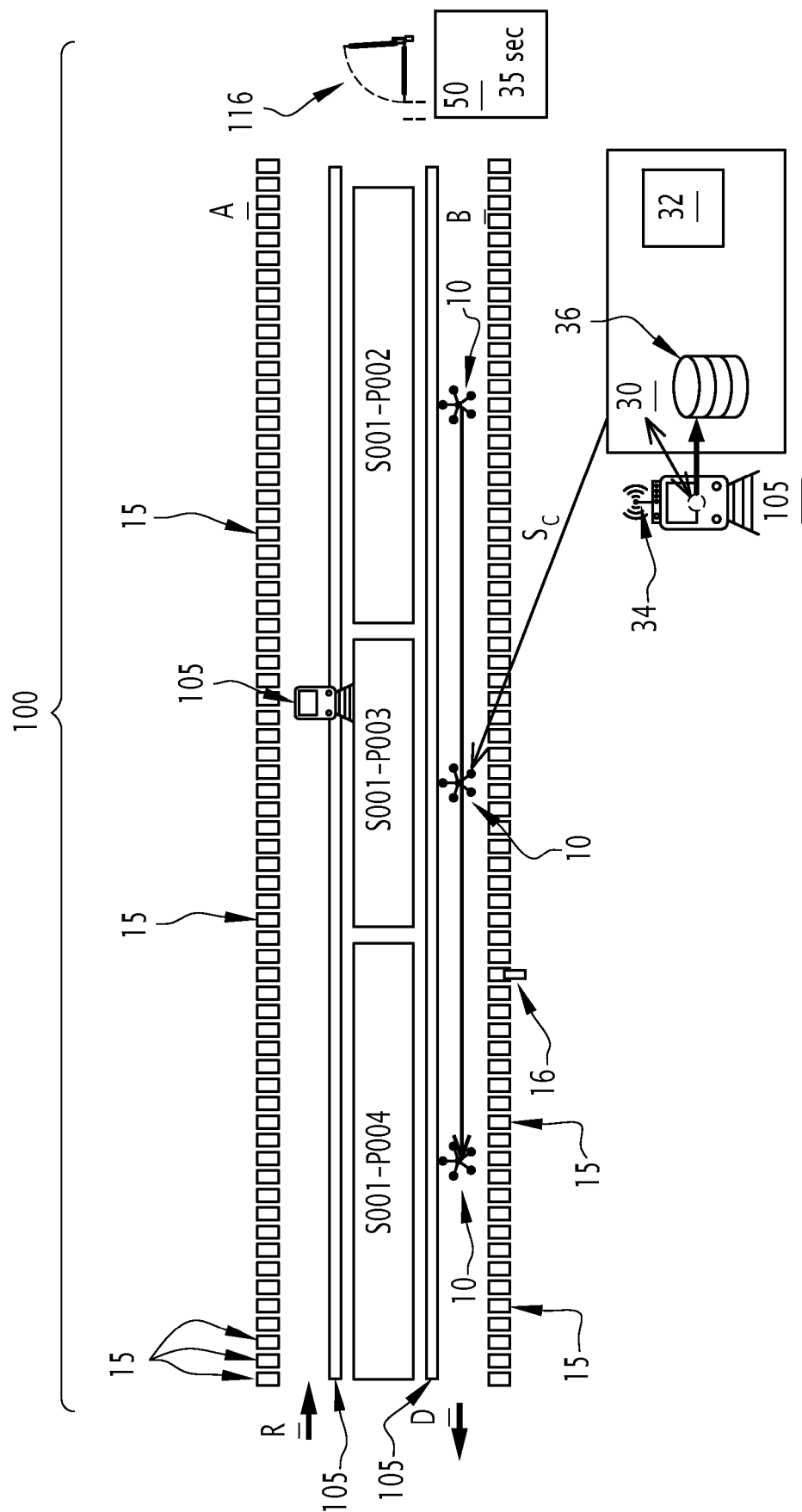


FIG. 1

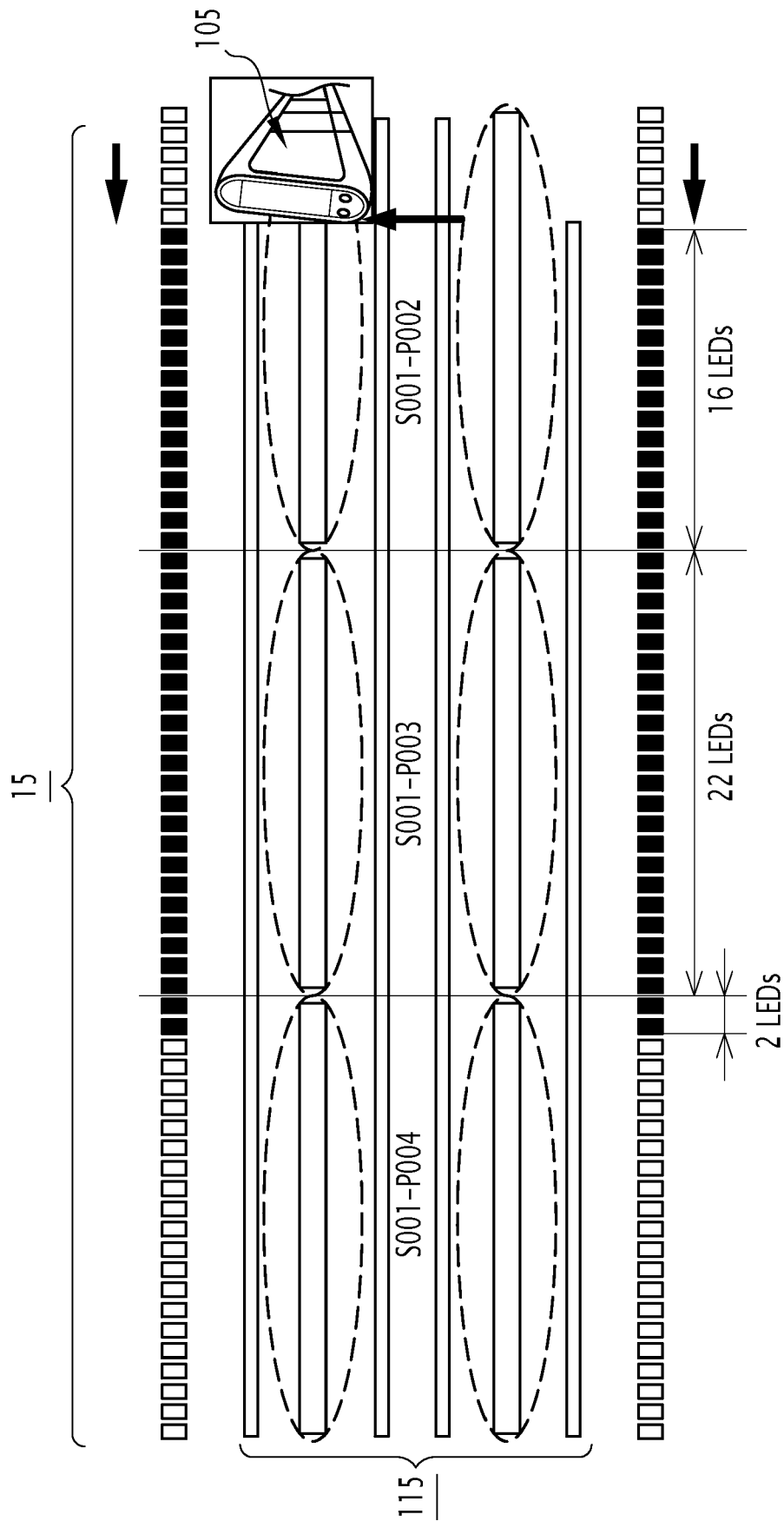


FIG.2

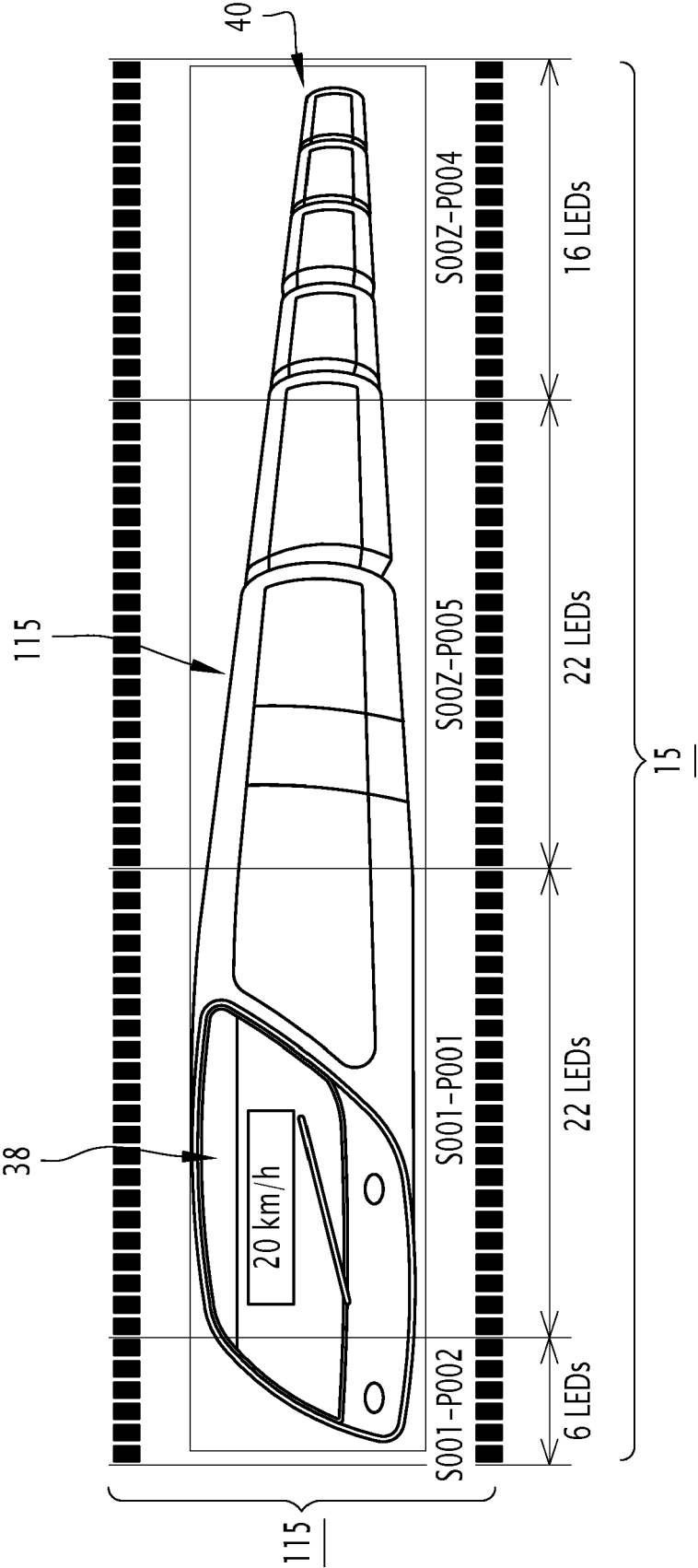


FIG.3

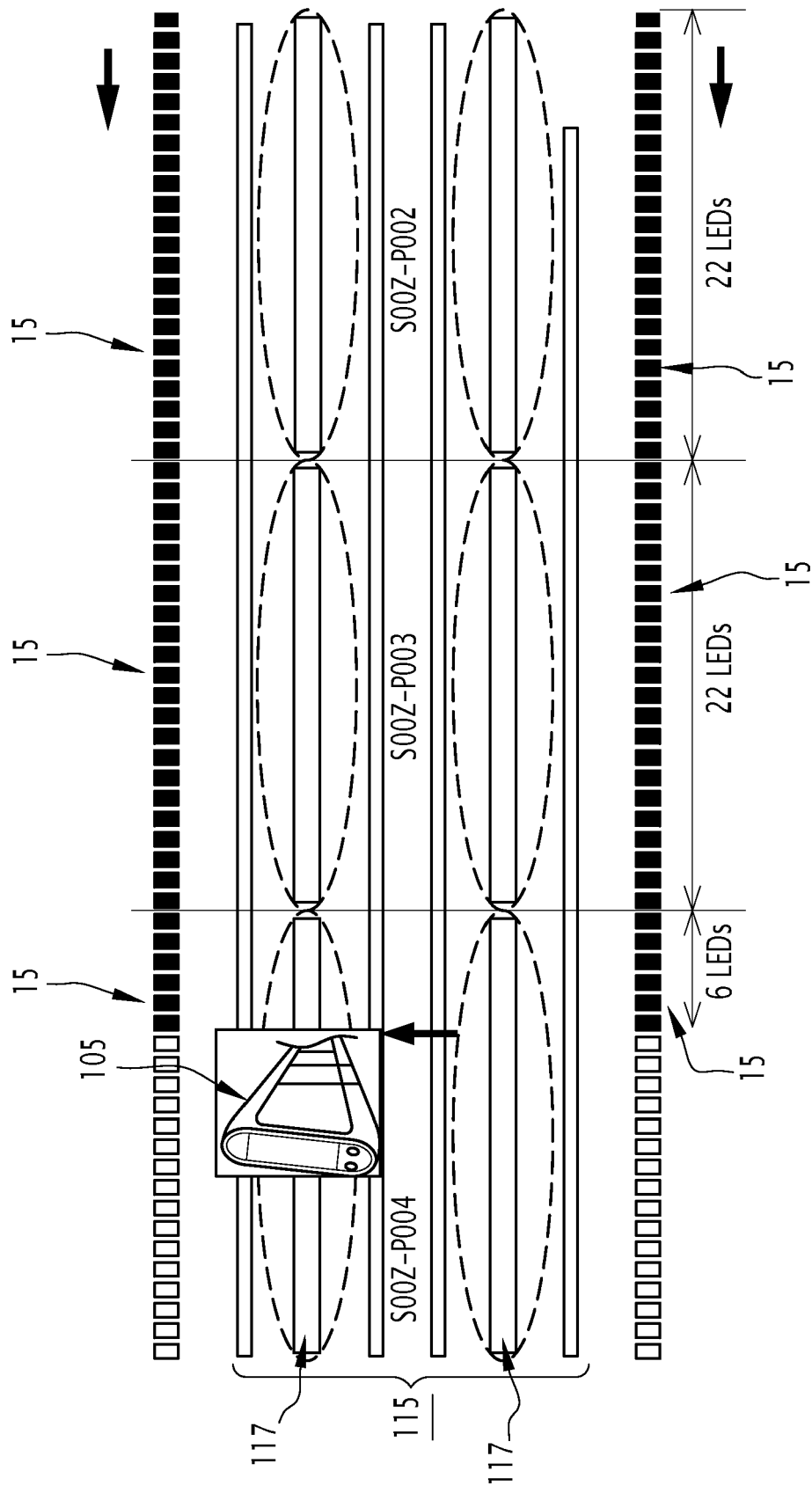


FIG.4

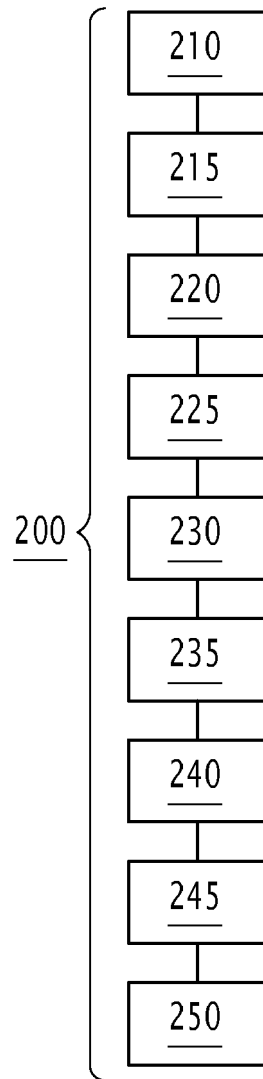


FIG.5



EUROPEAN SEARCH REPORT

Application Number
EP 21 18 5240

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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	FR 3 007 726 A1 (AIT EL HADJ MOHAMED [FR]; HESSABI MEHRDAD [FR]) 2 January 2015 (2015-01-02) * abstract * * page 11 - page 14; figures 3,4 * * page 1, line 1 - line 4 *	1,4-6,10	INV. B61L5/12 B61L23/06 B61L29/24
X	WO 2010/012040 A1 (RICH ELECTRIC CO AUSTRALASIA [AU]; MACEY BRETT ADRIAN [AU]) 4 February 2010 (2010-02-04) * page 11 * * page 22 - page 26; figures 7,9,10 *	1-5,7,8,10-13	ADD. B61L15/00 B61L15/02 B61L27/00
X	US 2017/282944 A1 (CARLSON RICHARD [US] ET AL) 5 October 2017 (2017-10-05) * paragraph [0030] - paragraph [0036] * * paragraph [0045] * * paragraph [0054] - paragraph [0057] *	1-7,9-13	
A	EP 1 916 879 B1 (ALCATEL LUCENT [FR]) 2 September 2009 (2009-09-02) * paragraph [0010] - paragraph [0011] *	4,5	TECHNICAL FIELDS SEARCHED (IPC)
A	US 2011/006912 A1 (SHEARDOWN KEITH BURTON [CA] ET AL) 13 January 2011 (2011-01-13) * claims 2,3,21,22 * * paragraph [0006] * * paragraph [0027] * * paragraph [0035] * * paragraph [0058] *	3,6,12	B61L
A	CN 107 813 850 A (SHANGHAI FUXIN INTELLIGENT TRANSP SOLUTIONS CO LTD) 20 March 2018 (2018-03-20) * paragraph [0002] - paragraph [0020] * * abstract * * paragraph [0037] * * paragraph [0042] *	1,2	
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 1 December 2021	Examiner Pita Priegue, Miguel
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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EPO FORM 1503 03.82 (P04C01)

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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 21 18 5240

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
FR 3007726 A1	02-01-2015	NONE	
WO 2010012040 A1	04-02-2010	NONE	
US 2017282944 A1	05-10-2017	US 2017282944 A1 US 2020062286 A1	05-10-2017 27-02-2020
EP 1916879 B1	02-09-2009	AT 442027 T EP 1916879 A1	15-09-2009 30-04-2008
US 2011006912 A1	13-01-2011	CA 2709171 A1 US 2011006912 A1	07-01-2011 13-01-2011
CN 107813850 A	20-03-2018	NONE	