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(54) **Status monitoring apparatus of railway vehicle**

(57) The invention provides an overhead panoramic image display device for enabling a driver operating a train to monitor the statuses of passengers exiting the train onto a platform and passengers entering the train from the platform via a monitor disposed on a driver's seat. A plurality of cameras 103a, 104a, 105a and 106a with imaging ranges set to cover the outer side of the

vehicle are disposed on a side wall of railway vehicles 101 and 102, which are used to take images of individuals 107, 108, 109 and 110 on the platform when the train stops at a station, wherein the camera images are converted to an overhead view and displayed as panoramic image on a monitor 111 on the driver's seat.

EP 2 397 386 A1

Description

BACKGROUND OF THE INVENTION

Field of the invention

[0001] The present invention relates to a status monitoring apparatus of a railway vehicle for monitoring passengers and the like positioned close to a side of the railway vehicle on the outer side and the inner side of the vehicle.

Description of the related art

[0002] Patent document 1 (Japanese patent application laid-open publication No. 2002-104189) discloses a train operation support system, a ground apparatus for train operation support, and a vehicle apparatus for train operation support.

[0003] The train operation support system, ground apparatus for train operation support and vehicle apparatus for train operation support disclosed in patent document 1 uses cameras mounted on a platform to pick up images of the vicinity of a boundary between the platform and the train and transmits the picked-up images to the train via radio communication. The train receives the picked-up images and displays the images on a liquid crystal display unit installed on the driver's seat of the train, and the train driver monitors the displayed images and operates the train while confirming its safety.

[0004] Further, patent document 2 (Japanese patent application re-publication No. W02007/015446) discloses a device and method for monitoring vehicle surroundings. The device and method for monitoring vehicle surroundings disclosed in patent document 2 comprises at least one camera installed on an own vehicle to take a video of the image around the own vehicle, an obstacle sensor for detecting an obstacle within an imaging range of the camera, a pixel synthesis unit for receiving a camera image taken by the camera and converting the camera image into a view point converted image seen from a virtual view point above the own vehicle, and a display device for displaying the view point conversion image converted by the pixel synthesis unit, wherein when a warning is given by a warning sound upon entry of an obstacle within an obstacle detection range of the obstacle sensor, an image of the obstacle detection range is synthesized with an obstacle image taken by the camera and included in the view point converted image to be in contact therewith.

[0005] The train operation support system, ground apparatus for train operation support and vehicle apparatus for train operation support disclosed in patent document 1 requires multiple cameras to be mounted on platforms and the picked-up images must be transmitted to the train via radio communication, so that the cost for installing multiple cameras on respective platforms becomes excessive, and devices must be installed in addition for

transmitting the picked-up images to the train via radio communication .

[0006] Moreover, the device and method for monitoring vehicle surroundings disclosed in patent document 2 comprises multiple cameras installed on the front, back and sides of a vehicle to take a video around the own vehicle and converting the camera image into a view point converted image seen from a virtual view point above the own vehicle, and specifically, when an obstacle enters the an obstacle detection range of the obstacle sensor, the image of the obstacle detection range is synthesized with the obstacle image imaged by the camera and included in the view point converted image to be in contact therewith. The patent document does not consider applying the art to a train formed by connecting multiple railway vehicles.

[0007] In the case of a train composed of multiple railway vehicles, it is important to ensure the safety of passengers entering and exiting the train from the time the train reaches the platform of a station to the time the train departs therefrom. If some passengers dash into the train, it is necessary to recognize such status smoothly and to ensure the safety of passengers.

SUMMARY OF THE INVENTION

[0008] The present invention aims at solving the problems of the prior art by providing a status monitoring apparatus for enabling a crew (such as a driver or a conductor) operating the train to monitor through a monitor disposed on a driver's cabin (driver's seat) the status of passengers positioned close to a side of the railway vehicle on an outer side and an inner side of the train exiting the train onto the platform or entering the train from the platform.

[0009] The status monitoring apparatus of a railway vehicle of the present invention comprises a detecting apparatus attached to a side of a vehicle constituting a train, and a signal processing function for processing each of a plurality of signals indicating a status of the side of the train detected via the detecting apparatus, characterized in that the signal processing function comprises a signal converting function for converting the plurality of signals, an image merging function for merging the converted signals to generate an integrated image, and a display function for displaying the merged image on a monitor disposed on the vehicle.

[0010] The status monitoring apparatus of a railway vehicle according to the present invention further characterizes in comprising an imaging apparatus disposed on an upper portion on an outer side of the side of the vehicle for acquiring an image, a function for subjecting the image obtained via the imaging apparatus to overhead view conversion, and a function for matching the overhead-view-converted image to form a continuous panoramic image.

[0011] Even further, the status monitoring apparatus of a railway vehicle according to the present invention

characterizes in comprising a reference detecting function for detecting as reference a width-direction end portion of a platform on which the vehicle stops from the image when displaying the image as a panoramic image, and an image merging function for merging the converted signals using the end portion as reference to form an integrated image.

[0012] The status monitoring apparatus of the railway vehicle according to the present invention further characterizes in that a moving body within the image is detected, and the detected moving-body is highlighted on the monitor.

[0013] The status monitoring apparatus of the railway vehicle according to the present invention further characterizes in that a sensor for detecting approximation of a moving body within an imaging range of the imaging apparatus to the vehicle is disposed on an outer side of the side of the vehicle.

[0014] Moreover, the status monitoring apparatus of the railway vehicle according to the present invention further comprises an imaging apparatus attached to an outer side of the vehicle above a door formed on a side of the vehicle constituting the train, an overhead view conversion function for subjecting images of an outer side and an inner side of a side of the vehicle taken via the imaging apparatus to overhead view conversion, an image emerging function for matching images converted via the overhead view conversion function to merge a continuous panoramic image, and a display function for displaying a merged image on the monitor disposed in the vehicle.

[0015] The status monitoring apparatus of a railway vehicle according to the present invention further comprises a sensor disposed on an outer side of a side of the vehicle constituting the train, and a signal processing function for processing a plurality of signals each indicating statuses of the side of the train detected via the sensor, wherein the signal processing function comprises an image converting function for converting the plurality of signals into image, and a display function for displaying the image converted from the signals via the image converting function on a monitor disposed on the train.

[0016] Further, the status monitoring apparatus of the railway vehicle according to the present invention characterizes in that the image displayed on the monitor is highlighted.

[0017] Even further, the status monitoring apparatus of the railway vehicle according to the present invention characterizes in that a rate of change of signals of the sensor detecting the status of the side of the train is calculated, and when the rate of change is greater than a predetermined threshold, highlights the image on the monitor converted from the signals.

[0018] According to the present invention, the crew such as the driver or the conductor operating the train can smoothly recognize the statuses of passengers exiting or entering the train by observing the monitor disposed on the driver's cabin when the train is stopped at

a station.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019]

FIG. 1 is a view showing an outline of a system for converting images from multiple cameras disposed on the railway vehicle to overhead view and displaying the same on a monitor disposed in a driver's cabin as a panoramic image;

FIG. 2 is an explanatory view of the overhead view conversion;

FIG. 3 is a plan view showing the positions and imaging ranges of cameras disposed on the railway vehicle;

FIG. 4 is a side view showing the positions and imaging ranges of cameras disposed on the railway vehicle;

FIG. 5 is an A-A cross-section of the railway vehicle shown in FIG. 4, illustrating the position and imaging range of each camera;

FIG. 6 is another plan view showing the positions and imaging ranges of cameras disposed on the railway vehicle;

FIG. 7 is another side view showing the positions and imaging ranges of cameras disposed on the railway vehicle;

FIG. 8 is a B-B cross-section of the railway vehicle shown in FIG. 7, illustrating the position and imaging range of each camera;

FIG. 9 is a display example of a monitor disposed in the driver's cabin of the railway vehicle;

FIG. 10 is another display example of a monitor disposed in the driver's cabin of the railway vehicle;

FIG. 11 is another display example of the monitor disposed in the driver's cabin of the railway vehicle; FIG. 12 is a system configuration diagram of the status monitoring apparatus of a railway vehicle using cameras;

FIG. 13 shows another system configuration of a status monitoring apparatus of a railway vehicle using cameras;

FIG. 14 is an example of a system for detecting signals from multiple sensors disposed on the railway vehicle and displaying the same as image on the monitor in the driver's cabin;

FIG. 15 is a plan view showing the positions and detection ranges of sensors disposed on the railway vehicle;

FIG. 16 is a side view showing the positions and detection ranges of sensors disposed on the railway vehicle; and

FIG. 17 is a system configuration diagram of the status monitoring apparatus of the railway vehicle using sensors.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0020] The preferred embodiments of the present invention will now be described with reference to the drawings.

[Embodiment 1]

[0021] Now, we will describe a preferred embodiment in which the present invention is applied to a system for converting images from a plurality of cameras disposed on a railway vehicle to an overhead view and displaying the same on a monitor in a driver's cabin as a panoramic image.

[0022] FIG. 1 shows a train 100 composed of railway vehicles 101 and 102, wherein the railway vehicle 101 is equipped with a driver's cabin in which the driver or the conductor of the train works. Although not shown, each railway vehicle is composed of an underframe constituting a floor surface, side structures erected on both width direction ends of the underframe and constituting side walls of the vehicle, end structures erected on both longitudinal ends of the underframe, and a roof structure disposed on the upper ends of side structures and end structures. Cameras 103a, 104a, 105a and 106a are disposed on an outer side of the vehicle on one side wall of the railway vehicle above the doors 202 of the railway vehicles 101 and 102.

[0023] The imaging range of cameras 103a, 104a, 105a and 106a are set to the outer side of the railway vehicle along the longitudinal direction of the railway vehicle 101, and the cameras take images of passengers 107, 108, 109 and 110 on a platform 200 when a train 100 is stopped at a station. Although not shown, cameras are disposed also on the other outer side of the railway vehicles 101 and 102 constituting the train 100.

[0024] Further, FIG. 1 shows an example in which cameras 103a, 104a, 105a and 106a are disposed on the side wall of the railway vehicle above the doors 202, but the positions in which cameras or sensors are disposed in embodiments 1 through 3 of the present invention are not restricted to the area above the doors 202, and can be selected from any position capable of covering the required imaging range on the outer side of the railway vehicle close to the connecting sections between the side structure and the roof structure constituting the railway vehicle.

[0025] The imaging range on the outer side of the railway vehicle can be covered by using only a small number of cameras if wide angle cameras having an imaging angle of approximately 180 degrees in the lateral direction (longitudinal direction of the railway vehicle 101) are adopted as cameras 103a, 104a, 105a and 106a. A monitor 111 disposed in the driver's cabin displays an image formed by subjecting the images taken by the cameras 103a, 104a, 105a, 106a and other cameras disposed on the railway vehicle to correction for correcting lens dis-

tortion, converting the corrected image to overhead view, and then composing a panoramic image therefrom.

[0026] The images taken by the cameras 103a and 104a are subjected to overhead view conversion and displayed on the monitor 111 as an image 112. Similarly, the images taken by the cameras 105a and 106a are subjected to overhead view conversion and displayed on the monitor 111. Images 112, 113 and 114 are merged continuously so that there is no leak in the imaging range covered by the cameras, and displayed on the monitor 111 as an integrated panoramic image as if the image taken by a single camera is subjected to overhead view conversion.

[0027] Similarly, all the overhead view images other than images 112 and 113 taken by the cameras on the railway vehicle disposed on the platform 200 side are converted into a continuous panoramic image and displayed. If the overhead view images of all the cameras cannot be displayed due to the imitation of size of the monitor 111 in the width direction (lateral direction), the images can be displayed as a multiple column image 119 having multiple columns in the vertical direction (height direction) of the monitor 111.

[0028] Individuals 107, 108, 109 and 110 on the platform 200 are subjected to overhead view conversion and displayed as images 115, 116, 117 and 118 on the monitor 111. Further, since the monitor 111 displays images showing the car numbers and positions of doors of the railway vehicles together with the overhead image of the railway vehicles, the operator can specify the respective railway vehicles corresponding to the overhead-view-converted images 112, 113 and 114.

[0029] FIG. 2 is an explanatory view of the overhead view conversion. Overhead view conversion refers to converting the actual image taken by the camera 103a disposed on the other side of the upper portion of the door 202 of the railway vehicle 101 to a virtual image as if the image is taken by a camera 201 disposed virtually above (approximately directly above) the platform 200.

[0030] Now, a method for composing a panoramic image from the camera images subjected to overhead view conversion and obtaining a final panoramic image will be described. At first, all the pixels constituting the image taken via the camera disposed on the upper outer side of the door 202 formed on the side wall of the vehicle 101 are relocated to positions having removed lens distortion by referring to a datasheet disclosing lens distortion.

[0031] Next, the image having been subjected to lens distortion correction is converted from an image having the camera view point on the upper outer side of the side wall of the railway vehicle to a camera view point virtually moved to a position directly above the imaging range. The overhead view conversion is performed by relocating the pixel positions of the actually taken image via geometrical coordinate transformation to pixel positions supposedly obtained via a camera view point directly above the imaging range based on the installation angle of the camera (depression angle), the installation height of the

camera and the focal distance of the camera, assuming that all subjects within the imaging range are planar objects capable of having their heights ignored.

[0032] FIG. 3 is a planar view showing the positions of cameras disposed on the railway vehicle and the imaging ranges thereof. Two doors 202 are disposed on each side wall of the railway vehicle 101, and cameras 103a, 104a, 103b and 104b are disposed on the side walls on the outer side of the railway vehicle 101 above each door 202. FIG. 3 illustrates an example in which the direction of optical axis of each camera 103a, 104a, 103b and 104b corresponds to the outer direction of the railway vehicle. The imaging range 301 corresponds to camera 103a, and together with imaging ranges 302, 303 and 304 of cameras 104a, 103b and 104b, the installed cameras have imaging angles capable of covering the outer side of the car body on both sides of the railway vehicle 101.

[0033] FIG. 4 is a side view showing the positions of cameras disposed on the railway vehicle and imaging ranges thereof. FIG. 4 is a view in which the railway vehicle 101 of FIG. 3 is viewed from the outer direction in the width direction of the vehicle. The vehicle 101 has doors 202 and 202 and windows 203, wherein cameras 103a and 104a are disposed on outer side walls of the railway vehicle above the doors 202.

[0034] The boundary section between the imaging range 301 of camera 103a and the imaging range 302 of camera 104a has an overlapped portion belonging to both imaging ranges, so that the passengers or the like on the platform 200 can be taken by the camera without fail.

[0035] FIG. 5 is an A-A cross-sectional view of the railway vehicle shown in FIG. 4, wherein the position and the imaging range of the camera are shown. A camera 103a is disposed on the outer side of the vehicle above the door 202 disposed on one side wall of the vehicle 101. The imaging range 301 of the camera 103a is set on the platform 200, so that the passengers and the like on the platform 200 are taken via the camera.

[0036] Similarly, a camera 103b is disposed on the outer side of the vehicle above the door 202 disposed on the other side of the vehicle 101, and when the platform 200 is positioned on the other side of the railway vehicle 101, the above-mentioned image can be taken via this camera.

[0037] Therefore, the crew such as the driver driving the train or the conductor can check the monitor disposed in the driver's cabin to promptly recognize the statuses of passengers exiting the train onto the platform and passengers entering the train from the platform, thereby enhancing the safety of the train.

[Embodiment 2]

[0038] FIG. 6 shows another plan view showing the positions and imaging ranges of cameras disposed on the railway vehicle. By arranging the optical axis of the

camera 103a illustrated in FIG. 3 in a perpendicular direction along the side wall of the railway vehicle 101 and by setting a large depression angle of the installed camera 103a, it becomes possible to take an image of both the subjects in an imaging range 305 on the outer side of the railway vehicle 101 and the subjects in an imaging range 306 on the inner side of the railway vehicle 101.

[0039] FIG. 7 is another side view showing the positions and imaging ranges of the cameras disposed on the railway vehicle. Doors 202 and 202 are disposed on the side of the railway vehicle 101, and cameras 103a and 104a are disposed on the outer side wall of the railway vehicle 101 above the respective doors 202.

[0040] The imaging range of the camera 103a includes the imaging range 305 on the outer side of the vehicle and the imaging range 306 on the inner side of the vehicle (refer to FIG. 6), wherein the imaging ranges 305 and 306 are set to the platform 200 on the outer side of the door 202 and to the inner side of the door 202. Although not shown, the imaging range of the camera 104a also includes both the inner side and the outer side of the railway vehicle 101.

[0041] FIG. 8 is a B-B cross-section of the railway vehicle shown in FIG. 7, which is another cross-sectional view showing the positions and imaging ranges of the cameras. A camera 103a is disposed on the outer side wall above the door 202 disposed on one side wall of the railway vehicle 101. The imaging range of the camera 103a includes the imaging range 305 of the upper side of the platform 200 on the outer side of the door 202 and the imaging range 306 on the inner side of the door 202, so that both the passengers on the platform 200 outside the vehicle and the passengers in the vehicle can be taken in the image via one camera at the same time.

[0042] Similarly, a camera 103b is disposed on the upper outer side of the door 202 on the other side of the vehicle 101, so that when the platform 200 is positioned on the other side of the railway vehicle 101, a similar image can be acquired.

[0043] FIG. 9 is a display example of the monitor arranged in the driver's cabin of the railway vehicle, wherein the passengers detected on the monitor are highlighted. The passengers on the platform 200 positioned close to the doors 202 of the railway vehicle 101 can be highlighted via frame borders 901, 902 and 903. In this case, when the distance between the doors 202 and the passengers is smaller than a given distance, that is, when the passengers are positioned close to the railway vehicle 101 and attention-seeking of the crew is necessary, for example, the corresponding passengers can be highlighted. Further, it is possible to detect the amount and direction of movement of the passengers per unit time and highlight the passengers possibly dashing into the train so that the crew can recognize such passengers promptly.

[0044] The crew can recognize the status easily and with further accuracy by adopting a function to display an enlarged view of the highlighted section when the crew

touches the highlighted sections 901, 902 and 903 on the screen of the monitor 111 to confirm the status of highlighted passengers.

[0045] FIG. 10 is another display example of the monitor in the driver's cabin of the railway vehicle. As shown in FIG. 10, when the passengers and the like on the platform 200 are positioned close to the doors 202 and 202 of the railway vehicle 101 and 102, only the sections 1001 and 1002 corresponding to where passengers are positioned close to the railway vehicles 101 and 102 can be highlighted. The highlighting conditions can be set arbitrarily, such as when the distance between the passenger and the railway vehicle falls within a given value (such as 1 m or shorter). Further, by highlighting only the sections 1001 and 1002 regarding the railway vehicle where passengers are positioned close to the vehicle by detecting the amount and direction of movement of the passengers per unit time, it becomes possible to promptly recognize which vehicle the passenger may dash into.

[0046] Similar to FIG. 9, the crew can recognize the status easily and with further accuracy by adopting a function to display an enlarged view of the highlighted sections 1001 and 1002 then the crew touches the highlighted sections 1001 and 1002 on the screen of the monitor 111 to confirm the status of highlighted passengers.

[0047] FIG. 11 shows yet another display example of the monitor in the driver's cabin of the railway vehicle, wherein an image having corrected the vibration amplitude caused by vibration of the railway vehicle or the like is displayed on the monitor.

[0048] In each railway vehicle, when the video image taken via the camera is subjected to overhead view conversion and merged into a panoramic image, it may not be possible to obtain a smooth panoramic image by removing the lens distortion from the images taken at each vehicle and displaying a merged panoramic image of the images subjected to overhead view conversion, due to the vibration or tilt of the respective vehicles 101 composing the train 100 or the influence of the distance between the respective vehicles 101 of the train 100 and the platform 200.

[0049] In that case, characteristic points, such as the width-direction ends of the platform 200, are extracted via image recognition from images obtained from each railway vehicle, and the images are merged so that these characteristic points are connected smoothly to obtain a panoramic image 1101. By adopting this method, it becomes possible to enhance the accuracy for calculating the distance between the passengers or the like on the platform 200 and the railway vehicles, so that the crew can recognize with further accuracy the level of approximation of the passengers to the doors 202 of the railway vehicles 101 and 102.

[0050] Although not shown, either in replacement of the images taken via multiple cameras, or in addition to these images, sensors such as infrared sensors or ultrasonic sensors can be disposed close to the doors of the vehicle to detect the approximation of passengers or the

like via the sensors, to specify the railway vehicle having detected signals from the sensors and to display the same on the monitor 111, so that the crew can recognize with even higher accuracy the level of approximation of the passengers to the doors 202 of the vehicle 101.

[0051] FIG. 12 is a system configuration of the status monitoring apparatus of the railway vehicle using cameras. Images taken via cameras 103a, 104a, 103b and 104b disposed on the railway vehicle 101 constituting the train 100 are subjected to lens distortion removal process and overhead view conversion process in an image processing LSI 1201, and these images are merged to form a panoramic image via a CPU (central processing unit) 1202, which is displayed on the monitor 111 of the driver's seat via a transmission line equipped on the train 100.

[0052] FIG. 13 is a system configuration of another status monitoring apparatus of a railway vehicle using cameras. Images taken via cameras 103a, 104a, 103b and 104b disposed on the respective railway vehicles 101 constituting the train 100 are connected to image processing LSI 1301 disposed in each railway vehicle where lens distortion removal process and overhead view conversion process are performed.

[0053] These images are merged into a panoramic image via the CPU 1302 and displayed on the monitor 111 in the driver's seat. According to the system shown in FIG. 13, both the images from cameras disposed on one side of the railway vehicle and the images from cameras disposed on the other side of the railway vehicle are subjected to image conversion via a single image processing LSI 1301, so that the number of necessary image processing LSIs is small and the costs for forming the image processing system are low.

[0054] Based on the above-described arrangement, the crew such as the driver or the conductor operating the train can recognize the statuses of passengers exiting the train onto the platform or of passengers entering the train from the platform promptly by checking the monitor disposed in the driver's cabin, thereby enhancing the safety of the train.

[Embodiment 3]

[0055] FIG. 14 shows an example of a system for detecting signals from a plurality of sensors disposed on the railway vehicle and to display the same on a screen of a monitor in the driver's cabin.

[0056] The train 100 is composed of railway vehicles 101 and 102, and on the railway vehicle 101 is disposed a driver's cabin in which the driver or the conductor of the train is seated. Since sensors 403a, 404a, 405a and 406a are not required to acquire a wide range of images like cameras, there is no restriction in the height in which the sensors are disposed, as long as they are disposed on the outer side of the vehicle on the side wall of the railway vehicle 101. For example, the sensors can be disposed at positions corresponding to a height of 500

mm on the side wall of the vehicle from the upper surface of the platform 200. The detection ranges of sensors 403a, 404a, 405a and 406a are set on the outer side of the railway vehicle, and the sensors sense the passengers or the like 107, 108, 109 and 110 on the platform 200 when the train 100 stops at a station. Further, sensors are similarly positioned at the opposite side walls (not shown) of the railway vehicles 101 and 102 constituting the train 100 shown in FIG. 14.

[0057] FIG. 14 shows an example where only the sensors 403a, 404a, 405a and 406a are disposed on the outer side wall of the vehicles 101 and 102, but the sensors can also be disposed in an additional manner to vehicles equipped with cameras as shown in embodiments 1 and 2.

[0058] When wide angle sensors with a sensing angle of approximately 180 degrees along the longitudinal direction of the railway vehicle 101 are selected as detection areas of sensors 403a, 404a, 405a and 406a, the outer side of the railway vehicle can be covered as the detection area by only a small number of sensors. The monitors 111 are equipped in the driver's cabin disposed on the railway vehicle 101, wherein the image created by processing signals detected by the sensors 403a, 404a, 405a and 406a is displayed.

[0059] An oval-shaped dashed line image 412 displayed on the monitor 111 is an image created based on the detected signal from the sensor 403, and similarly, images 413 and 414 are images formed by processing detection signals from the sensor 404a and image 415 is formed by processing signals from the sensor 406a.

[0060] Although not shown, sensors are disposed at similar areas of all the vehicles other than the vehicles 101 and 102 constituting the train 100, wherein the image corresponding to one side of the train 100 where the platform 200 is positioned is also similarly displayed continuously on the monitor 111. If the images from the sensor disposed on the train 100 cannot be displayed continuously in the longitudinal direction of the train 100 due to the limited width-direction size of the monitor 111, the images can be displayed as a multiple column image as shown in image 119.

[0061] The passengers 107, 108, 109 and 110 on the platform 200 are displayed as images 412, 413, 414 and 415 on the monitor 111, and the car number and the positions of doors are also displayed on the monitor, so that the crew can easily specify the railway vehicle corresponding to images 412, 413, 414 and 415.

[0062] FIG. 15 is a plan view showing the positions and detection ranges of sensors disposed on the railway vehicle. Sensors 403a, 404a, 403b and 404b are disposed above the respective doors 202, and the detection direction of the sensors are set to the outer side of the railway vehicle 101. In this case, the detection range corresponds to the frame border 501 of FIG. 15, wherein together with detection ranges 502, 503 and 504 of other sensors, the outer side of the vehicle can be covered by the detection ranges.

[0063] FIG. 16 is a side view showing the position and detection ranges of sensors disposed on the railway vehicle. The vehicle 101 has doors 202 and 202, and above the doors 202 are respectively disposed sensors 403a and 404a.

[0064] Sensor 403a has a detection range 501 and sensor 404a has a detection range 502 as the detection object range. The detection ranges 501 and 502 have an overlapped portion, by which the passengers and the like on the platform 200 can be detected without fail.

[0065] FIG. 17 is a system configuration diagram of the status monitoring apparatus of the rail way vehicle equipped with sensors. Signals detected via sensors 403, 404, 405 and 406 disposed on the respective vehicles 101 of the train 100 are each subjected to signal processing via signal processing LSI 1601 of sensor signals, and the image created via signal processing is merged in CPU 1602 and displayed on the monitor 111 in the driver's cabin. Thus, the crew such as the driver or the conductor operating the train can promptly recognize the statuses of passengers exiting the train onto the platform and passengers entering the train from the platform by checking the monitor disposed in the driver's cabin to thereby enhance the safety of the train.

[0066] When the sensor signal is processed via the signal processing LSI 1601, the rate of change of the signal or the like can be calculated to detect the area where the rate of change is high in the positive direction, to thereby check the abnormal approximation of passengers possibly dashing onto the train and to highlight the image where abnormal approximation is recognized.

[0067] The settings related to the positions and detection ranges of sensors on the railway vehicles constituting the train are not restricted to those shown in the drawings, and can be modified in various ways similar to the positions and imaging ranges of cameras. Further, the system configurations for realizing the present invention are not restricted to the illustrated examples, and can be modified in various ways.

Claims

1. A status monitoring apparatus of a railway vehicle comprising:

- a detecting apparatus attached to a side of a vehicle constituting a train; and
 - a signal processing function for processing each of a plurality of signals indicating a status of the side of the train detected via the detecting apparatus;
- characterized in that** the signal processing function comprises
- a signal converting function for converting the plurality of signals;
 - an image merging function for merging the converted signals to generate an integrated image;

- and
a display function for displaying the merged image on a monitor disposed on the vehicle.
2. The status monitoring apparatus of a railway vehicle according to claim 1, wherein
the detecting apparatus is an imaging apparatus disposed on an outer upper portion of the side of the vehicle for acquiring an image;
the signal converting function is a function for converting the image obtained via the imaging apparatus to an overhead view; and
the image merging function is a function to match the overhead-view-converted image to form a continuous panoramic image.

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 3. The status monitoring apparatus of a railway vehicle according to claim 2, wherein
the signal processing function comprises:

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 - a reference detecting function for detecting as reference a width-direction end portion of a platform on which the vehicle stops from the image when displaying the image as a panoramic image; and
 - an image merging function for merging the converted signals using the end portion as reference to form an integrated image.

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 4. The status monitoring apparatus of the railway vehicle according to any one of claims 1 through 3, **characterized in that**
a moving body within the image is detected, and the detected moving body is highlighted on the monitor.

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 5. The status monitoring apparatus of the railway vehicle according to any one of claims 2 through 4, wherein
a sensor for detecting approximation of a moving body within an imaging range of the imaging apparatus to the vehicle is disposed on an outer side of the side of the vehicle.

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 6. The status monitoring apparatus of the railway vehicle according to claim 1, further comprising
an imaging apparatus attached to an outer side of the vehicle above a door formed on a side of the vehicle constituting the train;
an overhead view conversion function for converting images of an outer side and an inner side of a side of the vehicle taken via the imaging apparatus to an overhead view;
an image merging function for matching images converted via the overhead view conversion function to merge a continuous panoramic image; and
a display function for displaying a merged image on the monitor disposed in the vehicle.

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 7. The status monitoring apparatus of a railway vehicle according to claim 1, further comprising:

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 - a sensor disposed on an outer side of a side of the vehicle constituting the train; and
 - a signal processing function for processing a plurality of signals each indicating a status of the side of the train detected via the sensor; wherein the signal processing function comprises:

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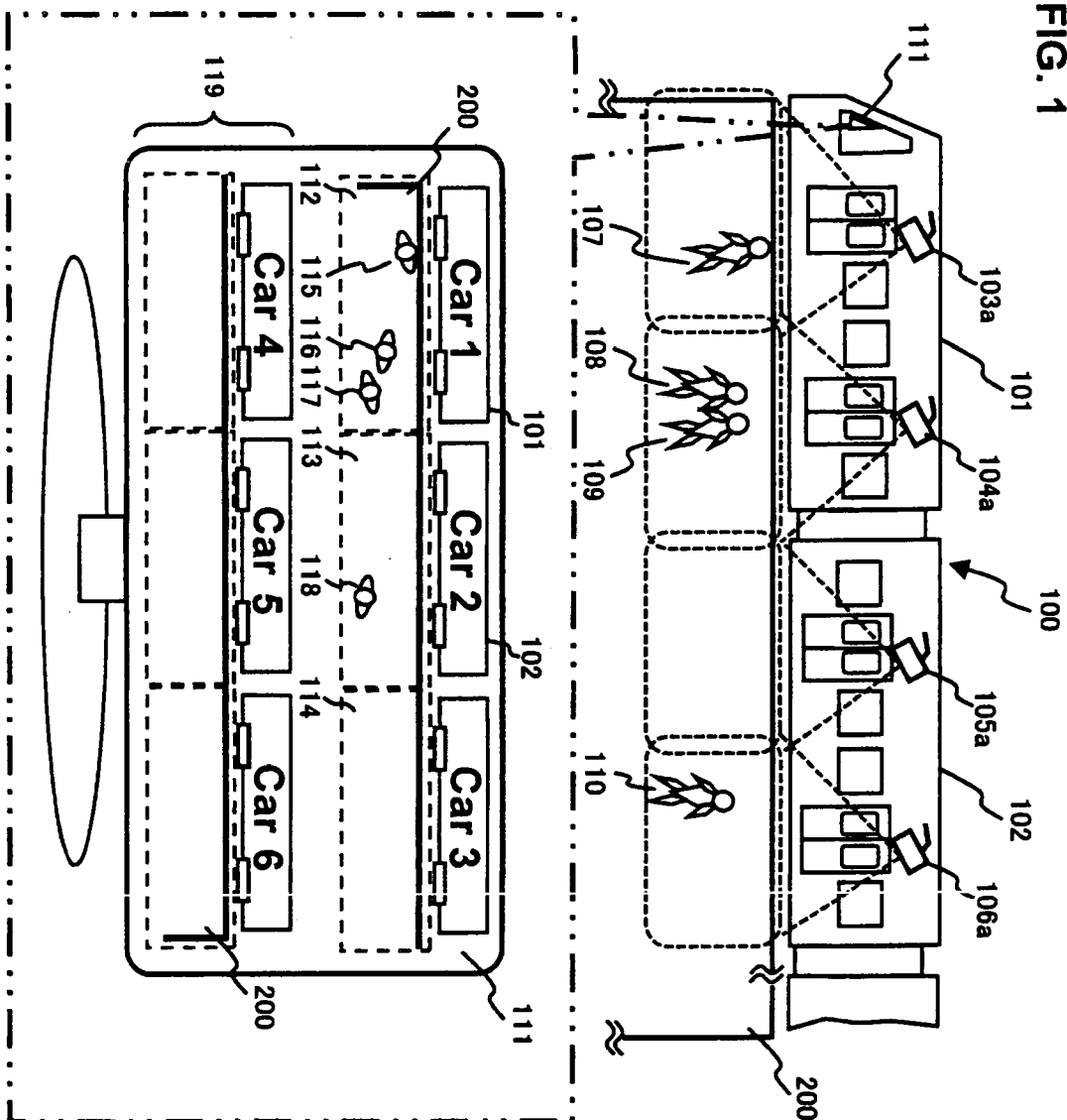
 - an image converting function for converting the plurality of signals into image; and
 - a display function for displaying the image converted from the signals via the image converting function on a monitor disposed on the train.

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 8. The status monitoring apparatus of the railway vehicle according to claim 7, **characterized in that**
the image displayed on the monitor is highlighted.

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 9. The status monitoring apparatus of the railway vehicle according to claim 8, **characterized in that**
a rate of change of signals of the sensor detecting the status of the side of the train is calculated; and when the rate of change is greater than a predetermined threshold, the apparatus highlights the image converted from the signal on the monitor.

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FIG. 1



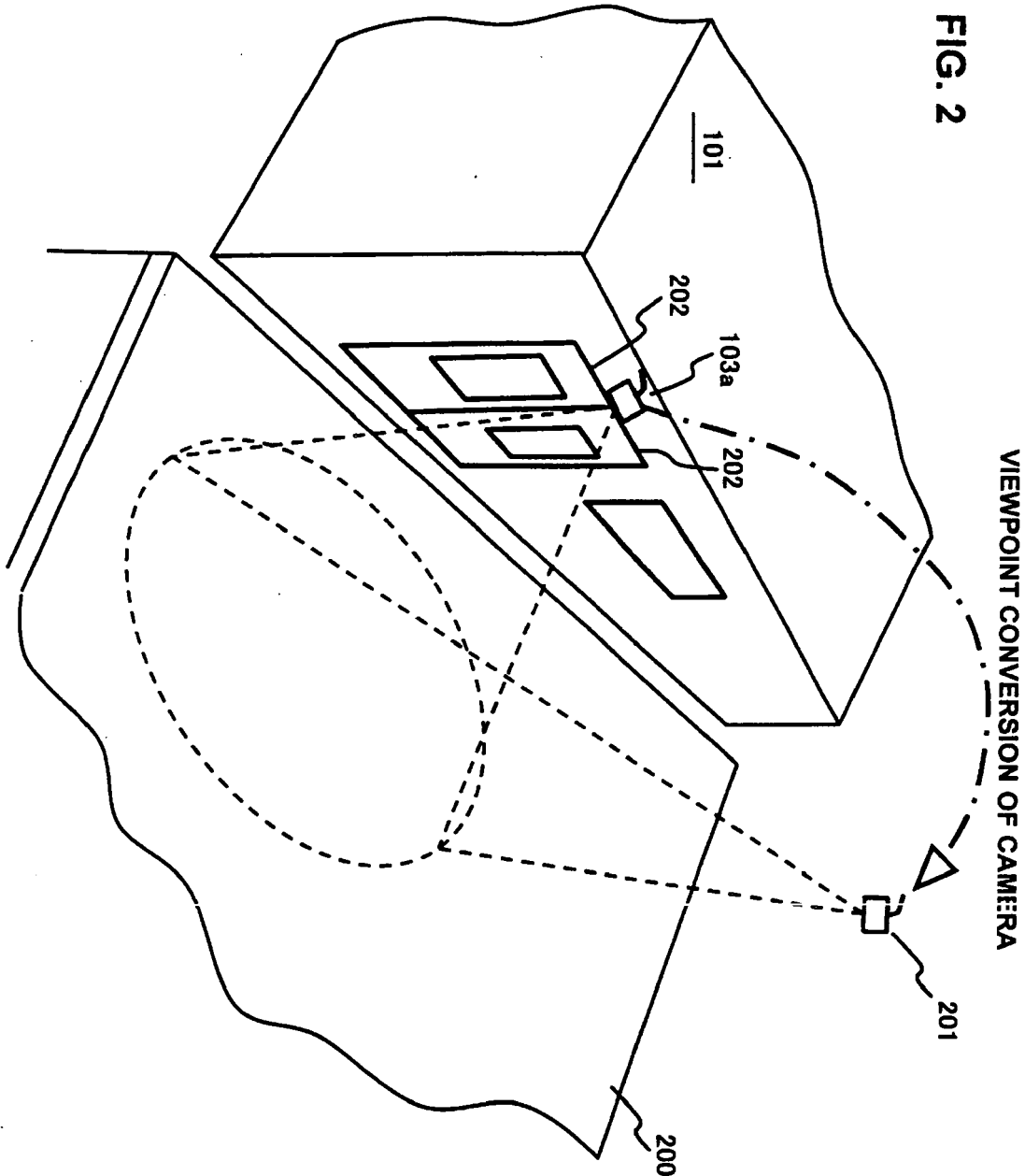


FIG. 3

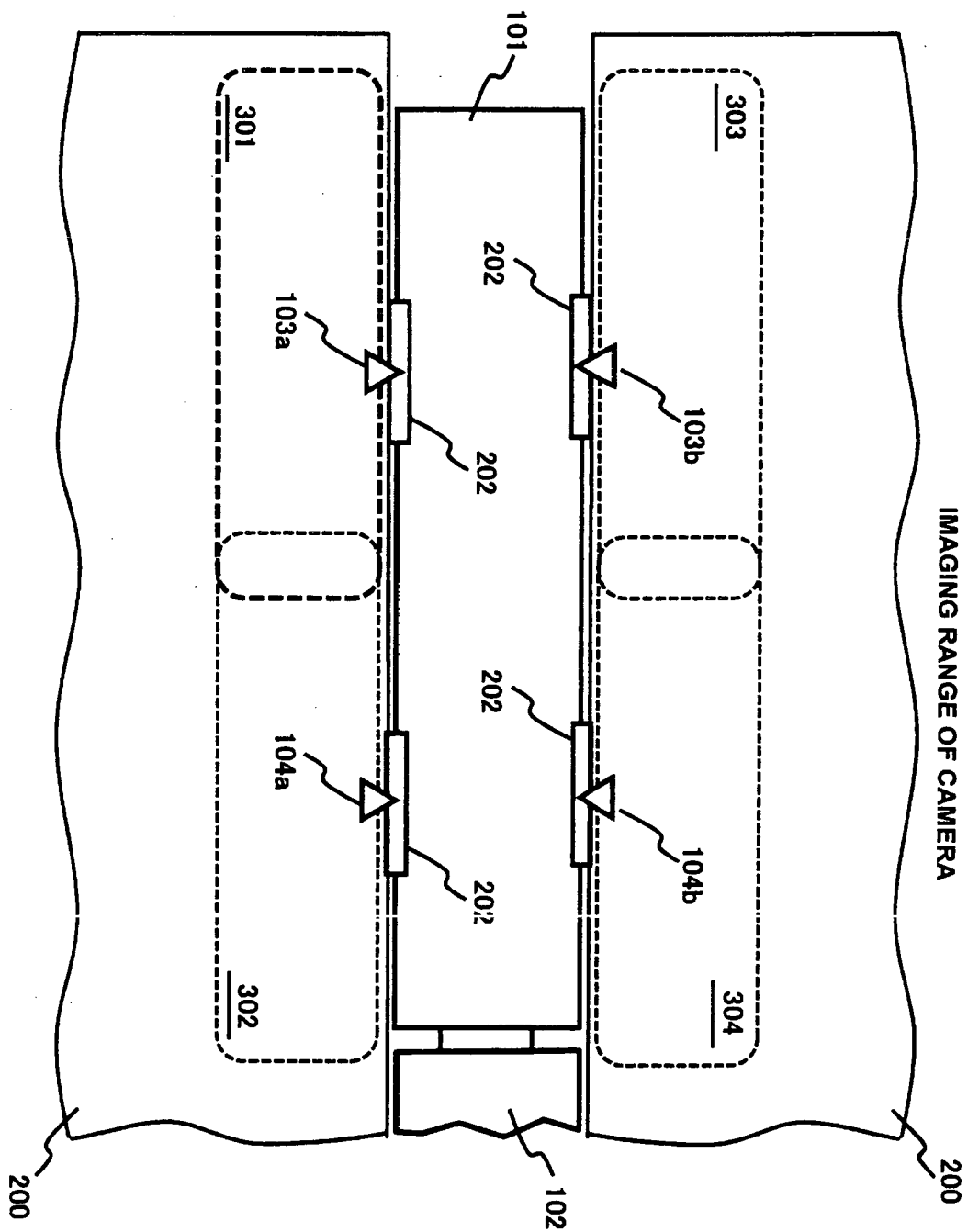


FIG. 4

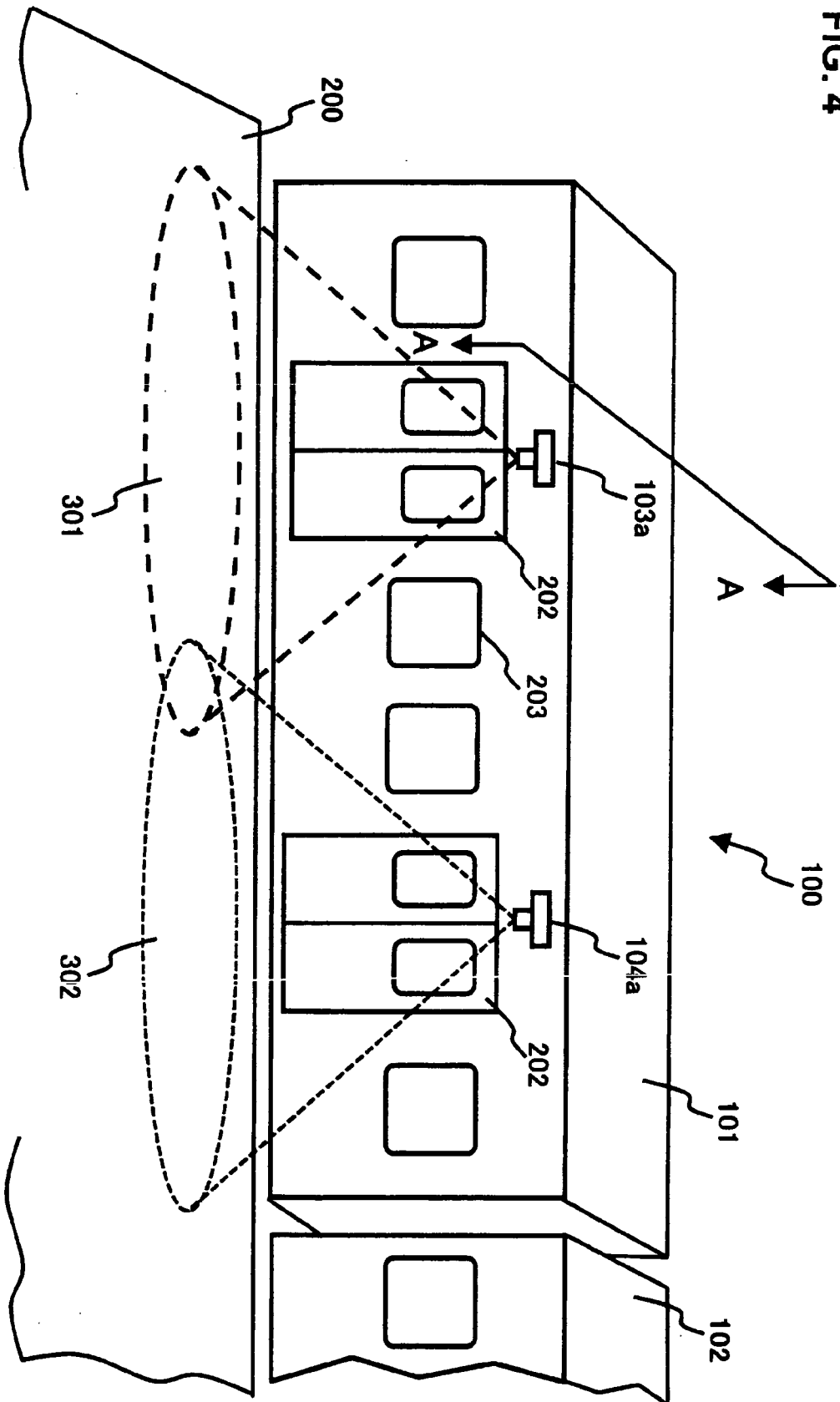


FIG. 5

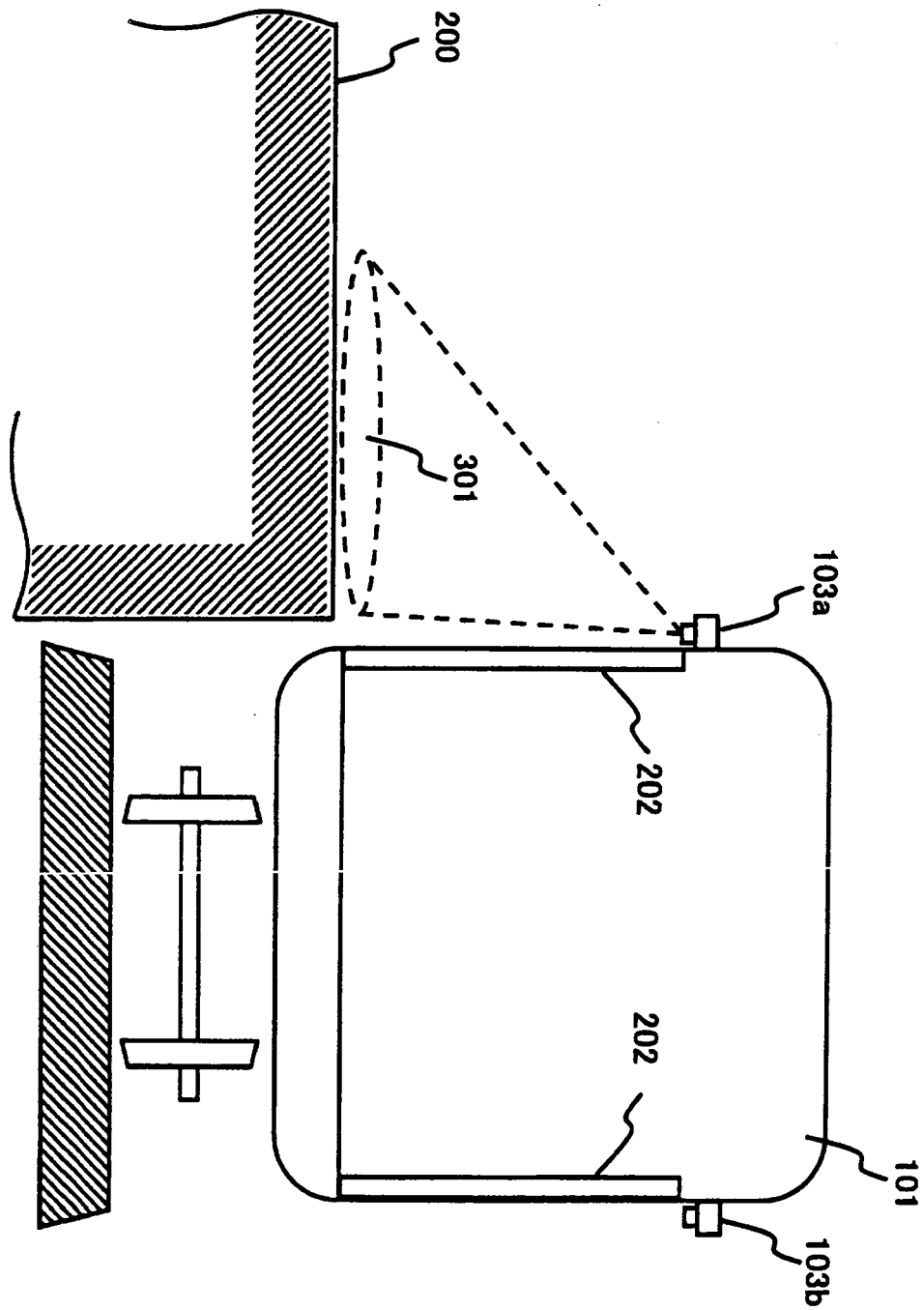


FIG. 6

IMAGING RANGE OF CAMERA

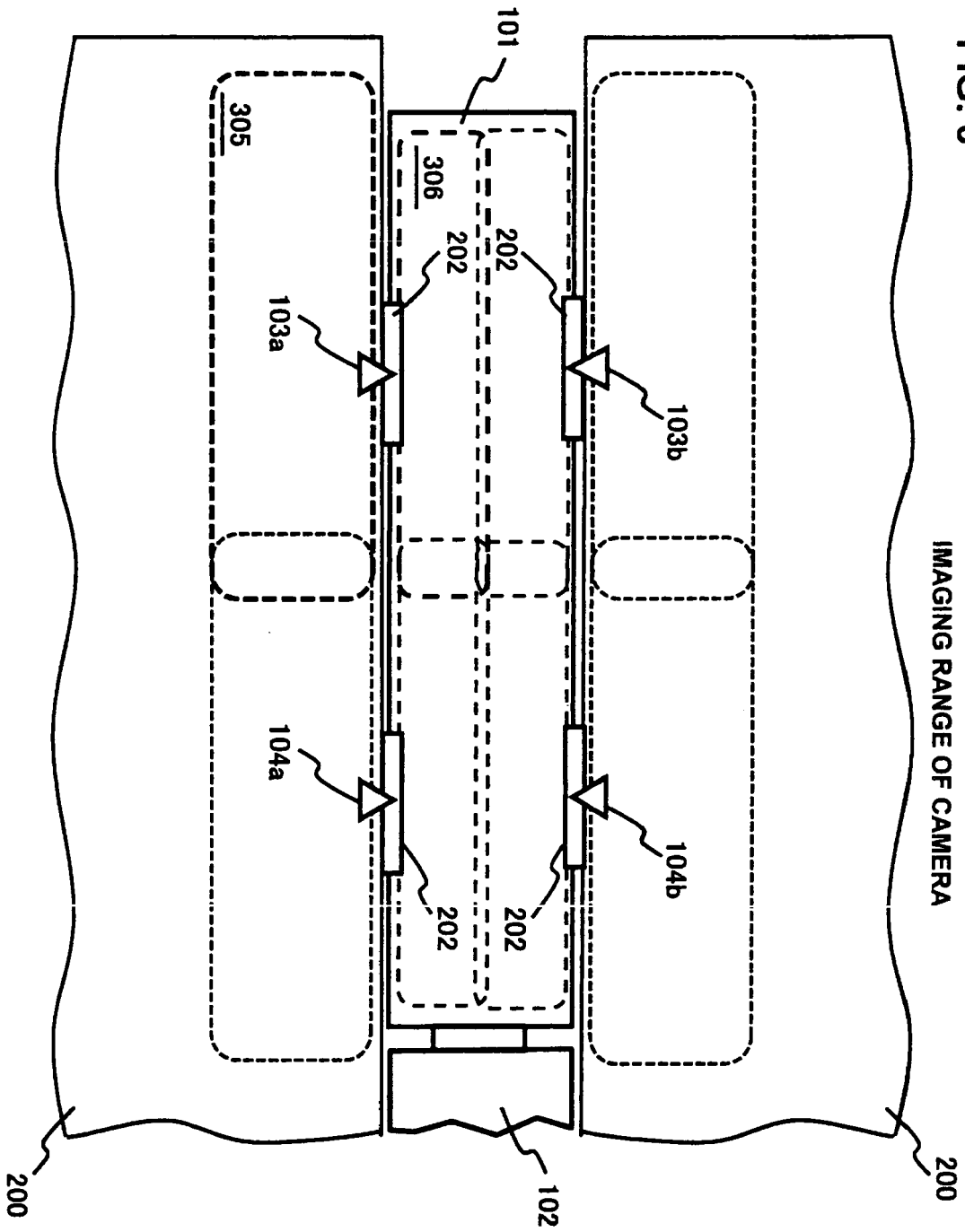


FIG. 7

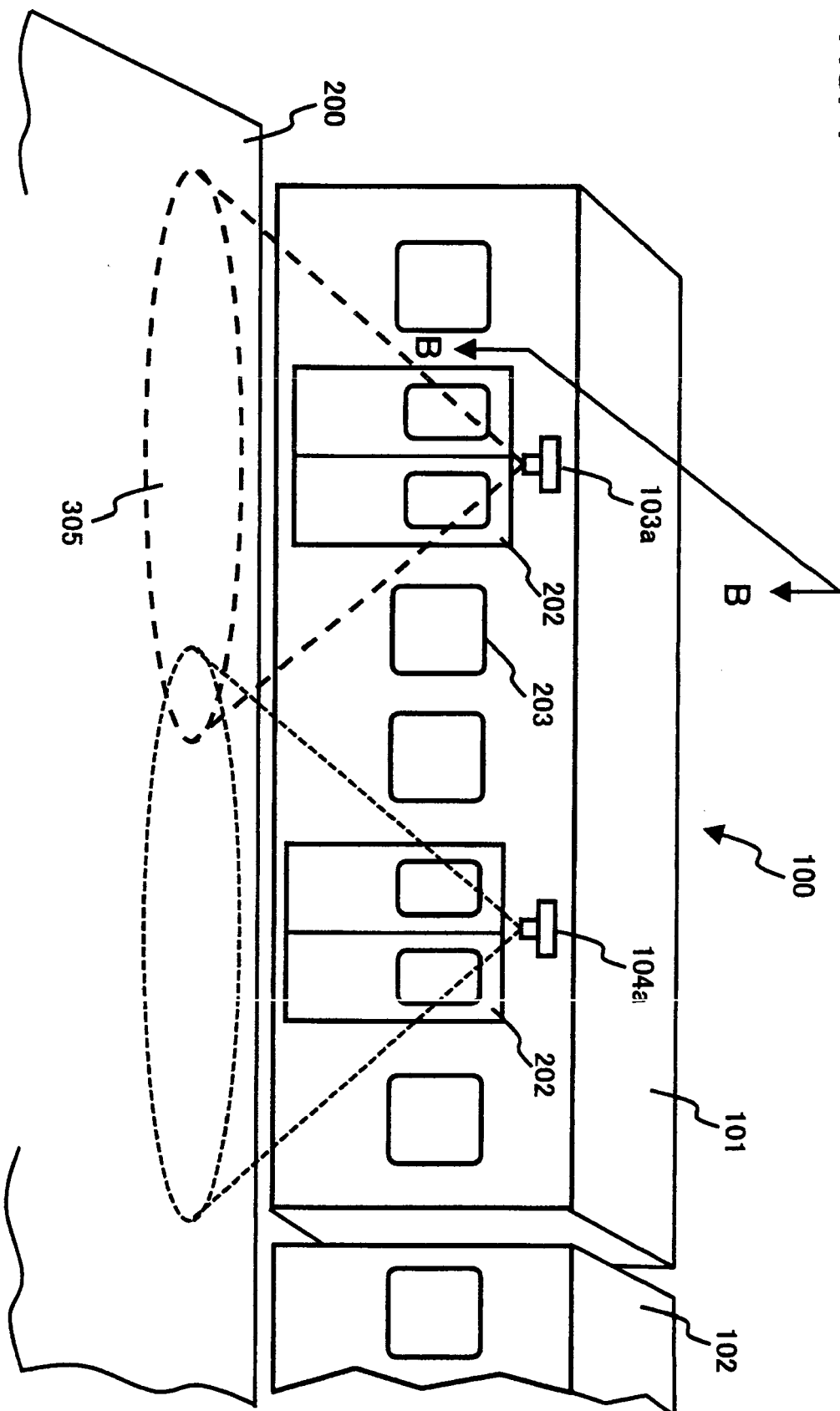


FIG. 8

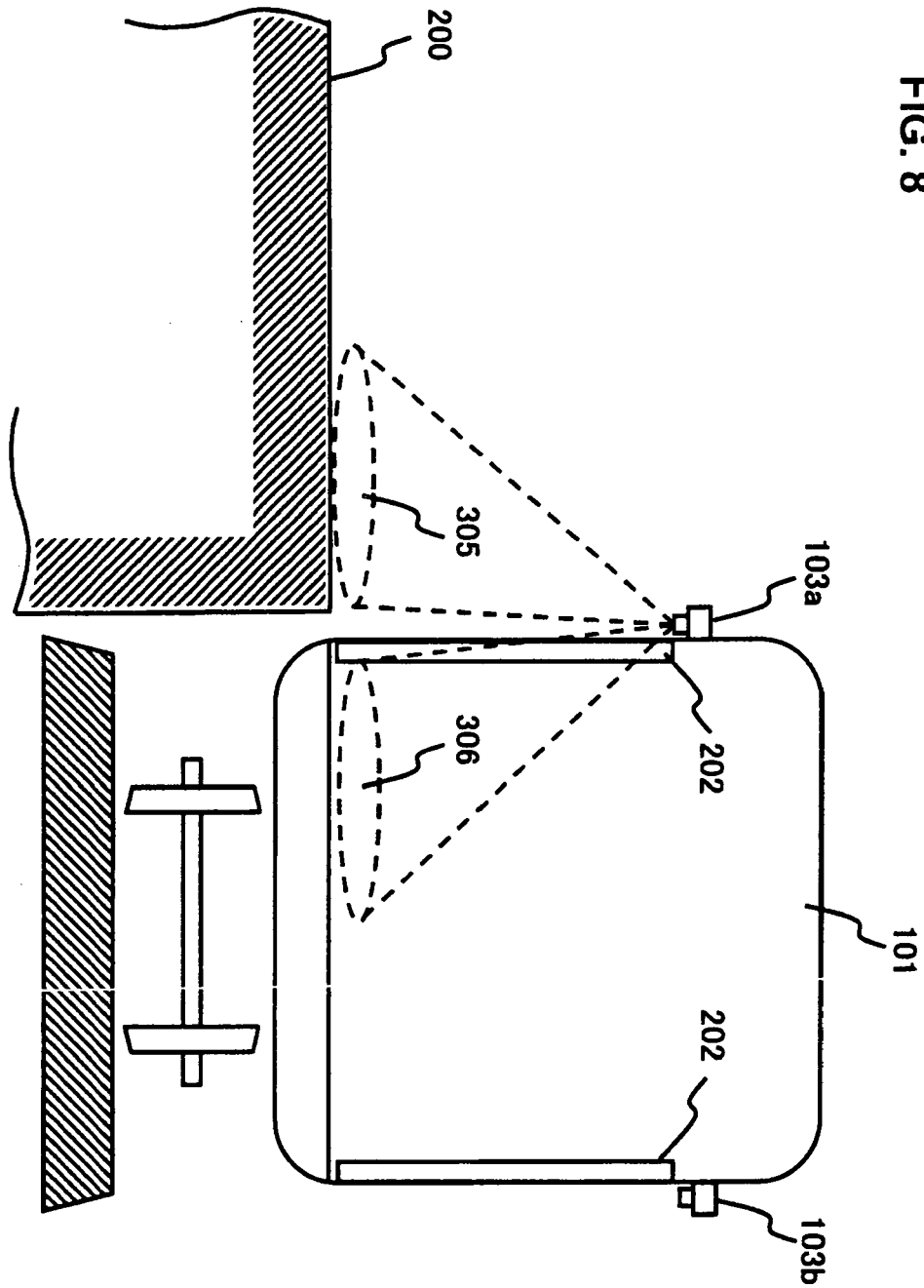


FIG. 9

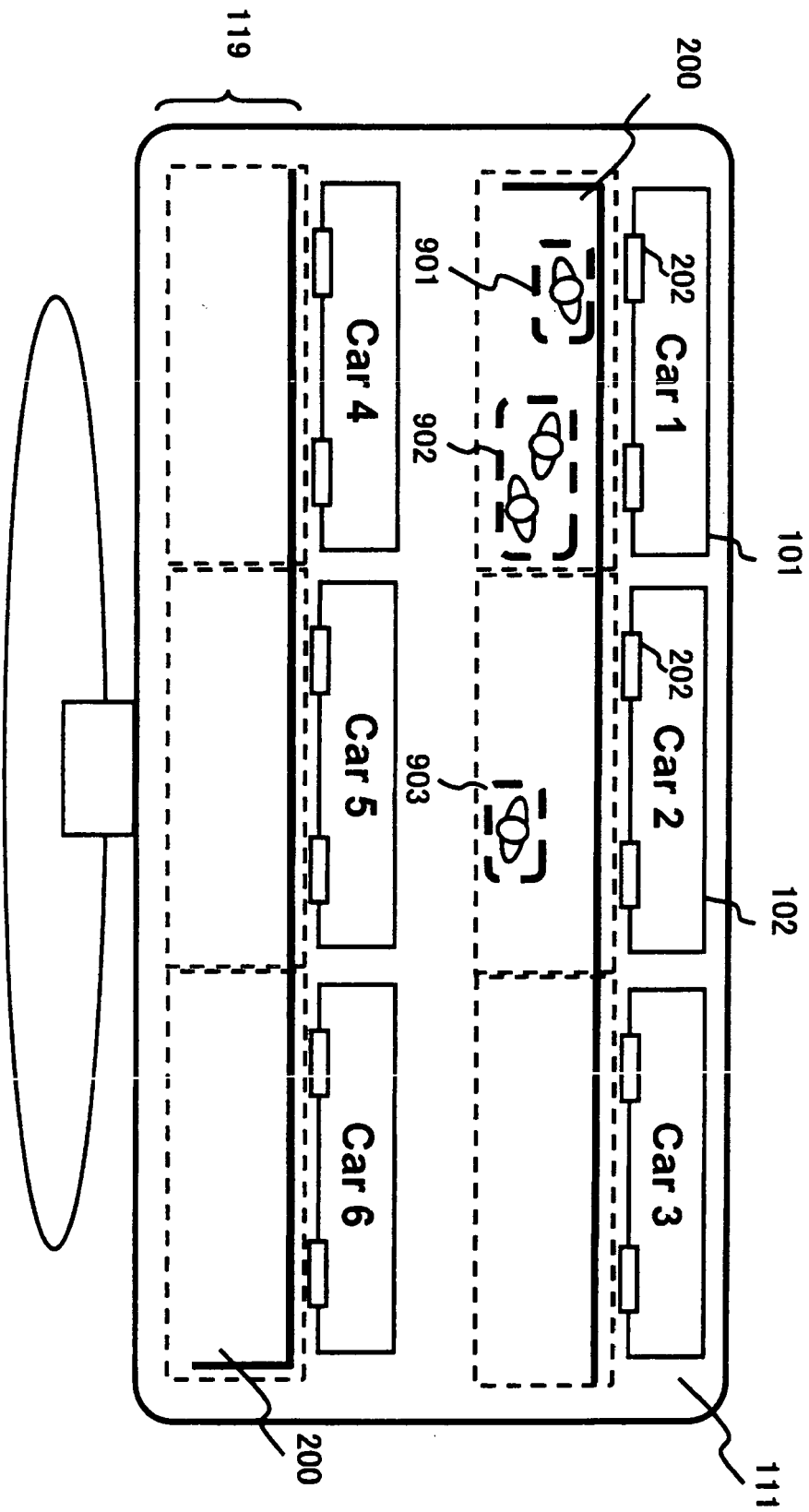


FIG. 11

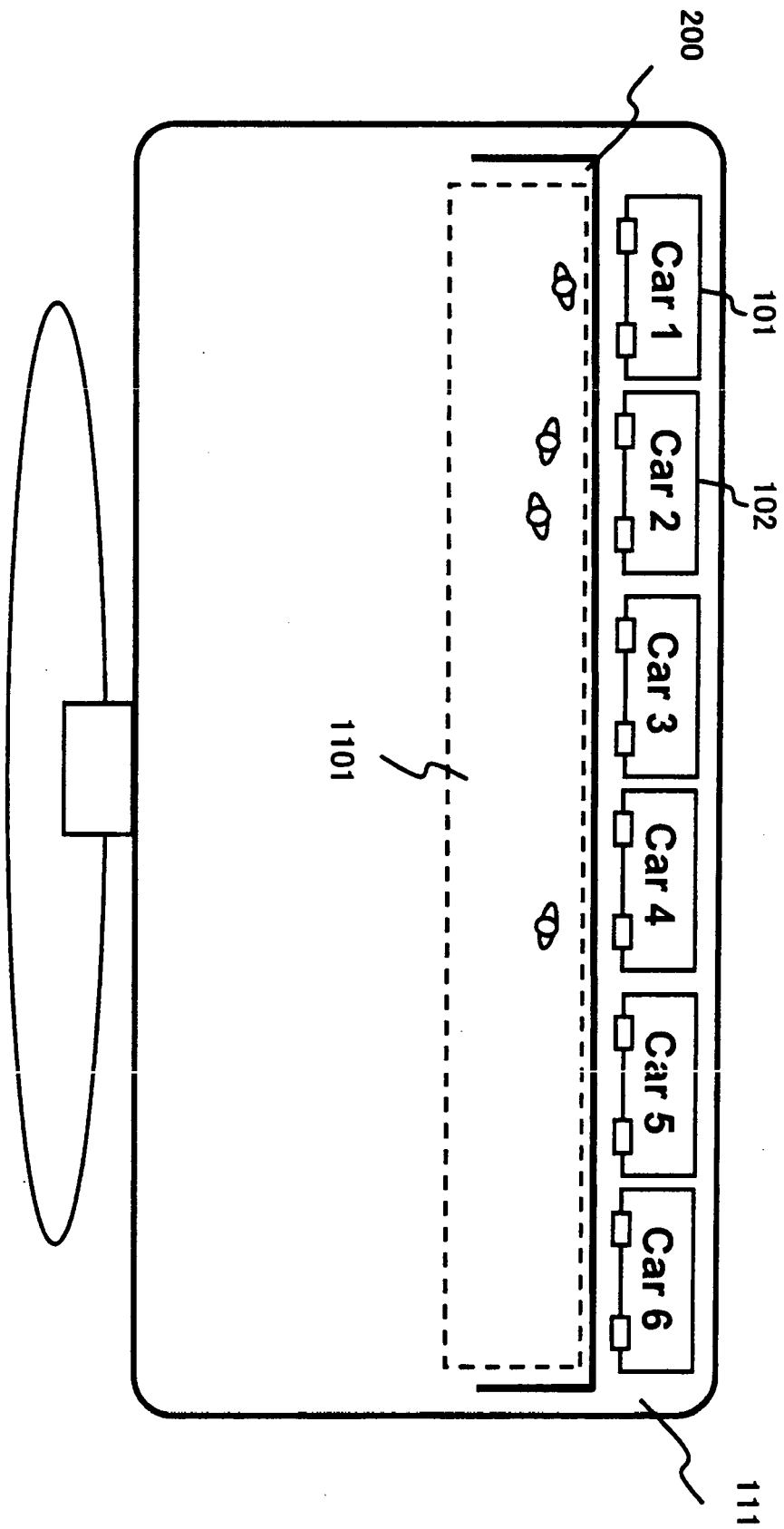


FIG. 12

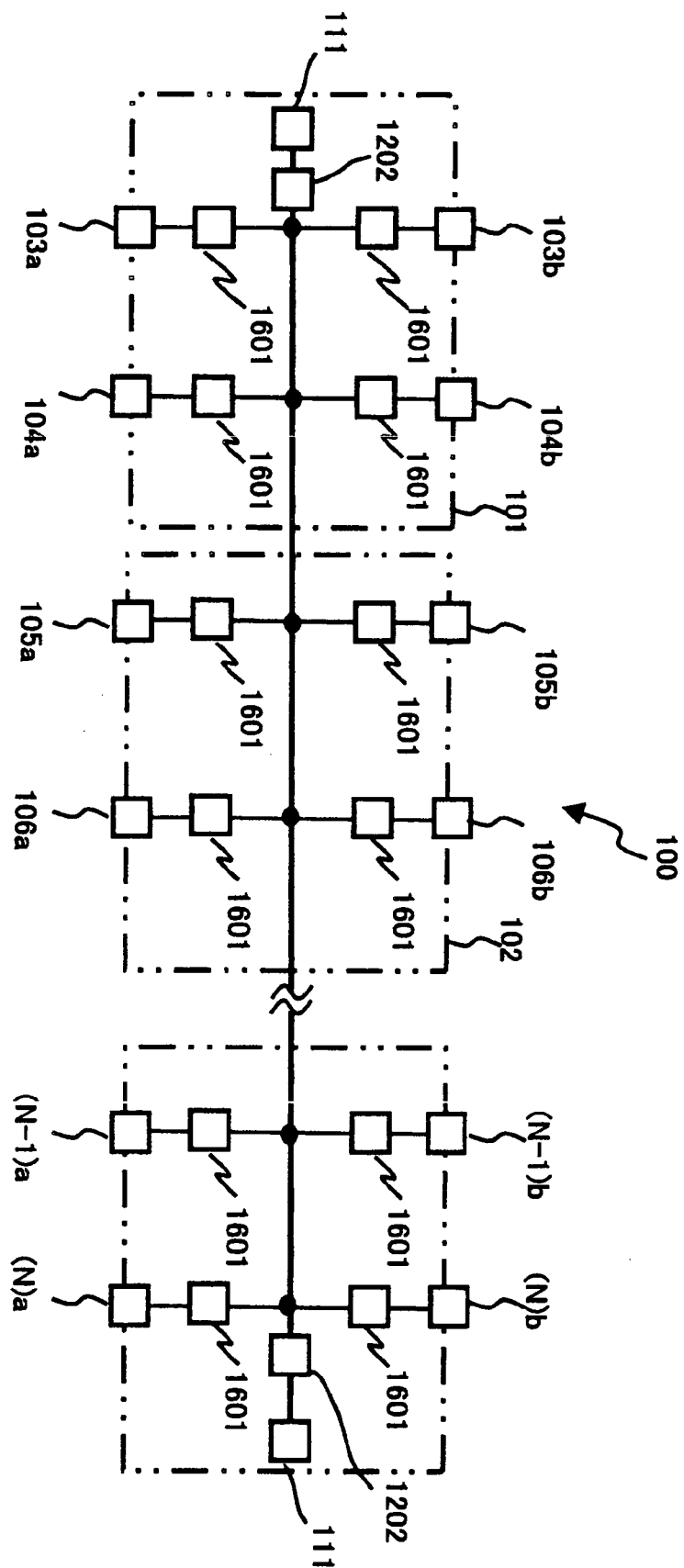


FIG. 13

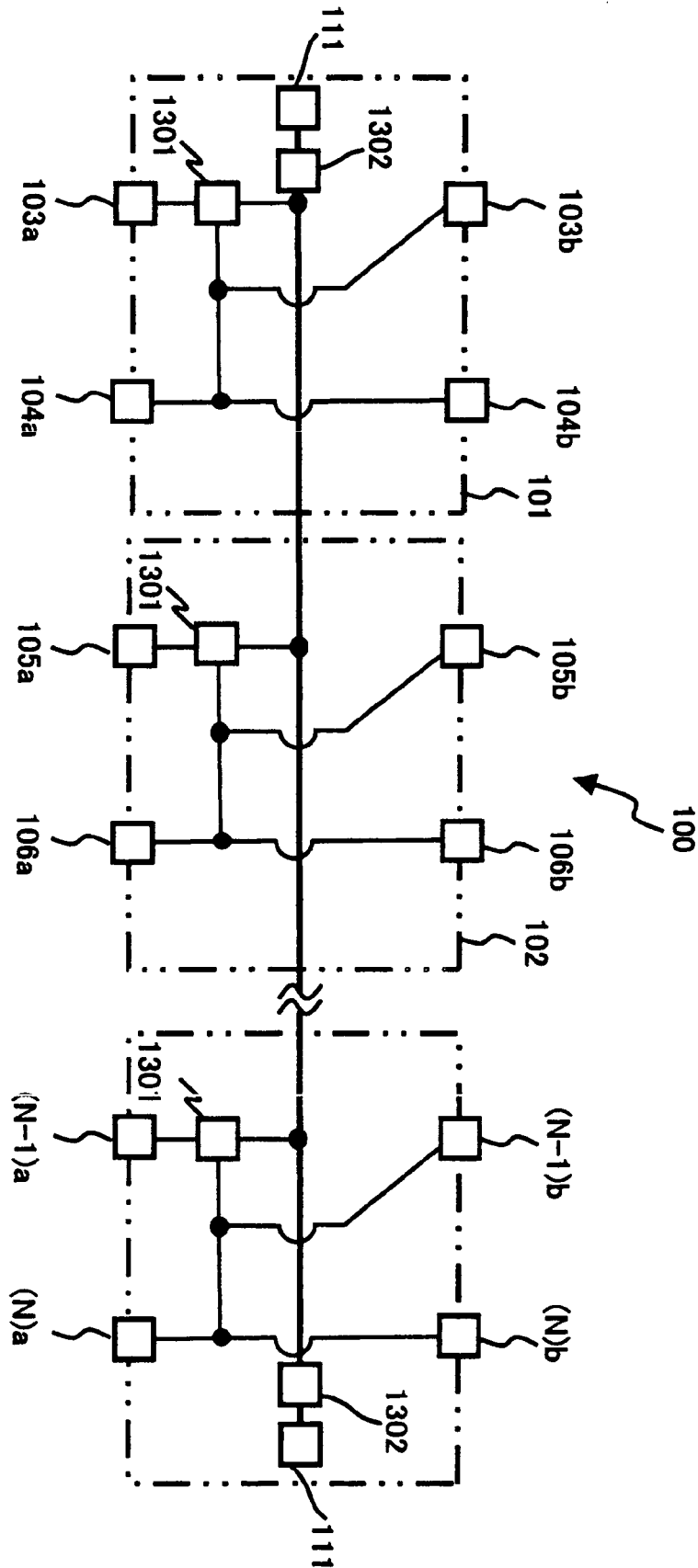


FIG. 14

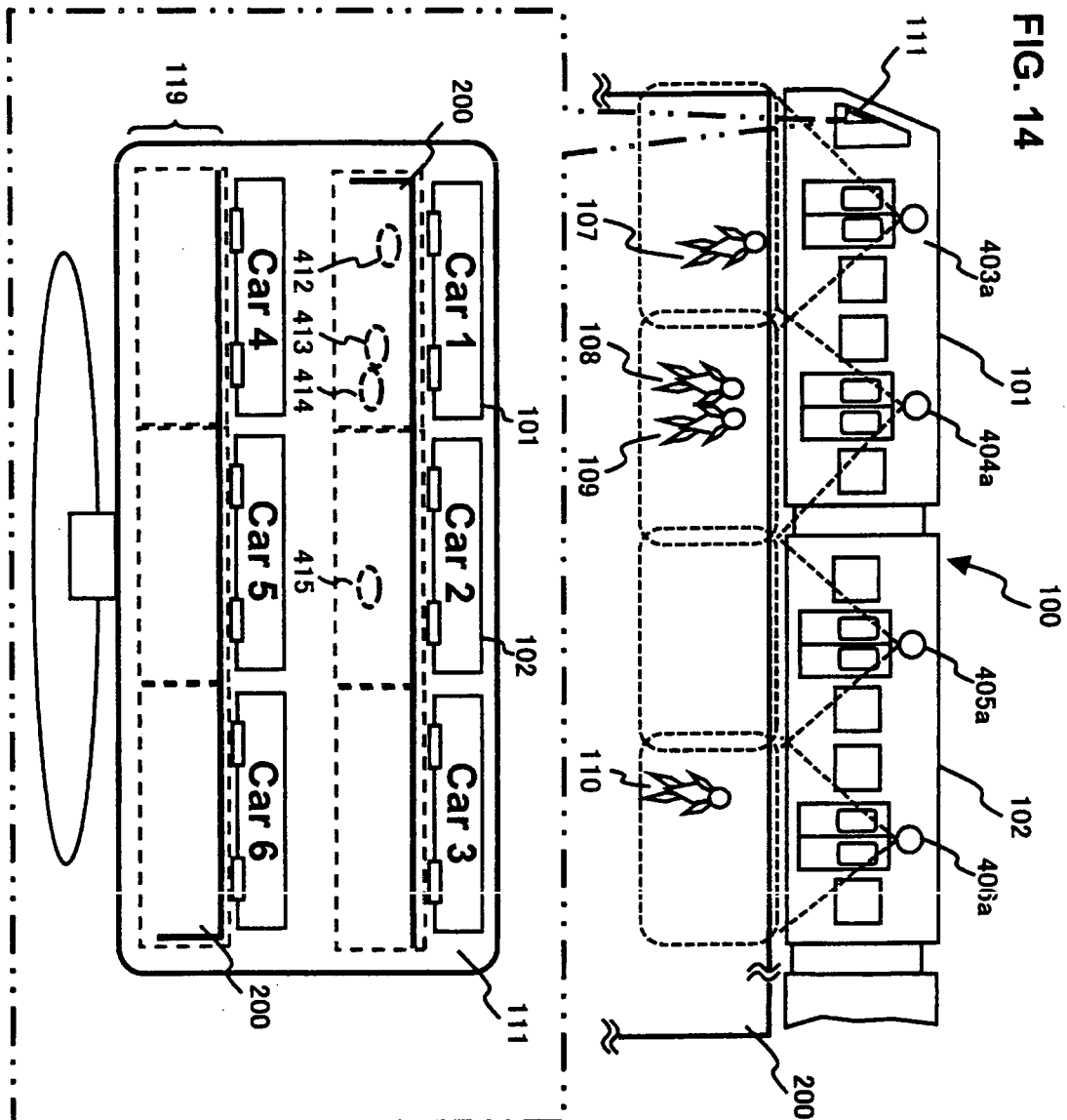


FIG. 15

DETECTION RANGE OF SENSOR

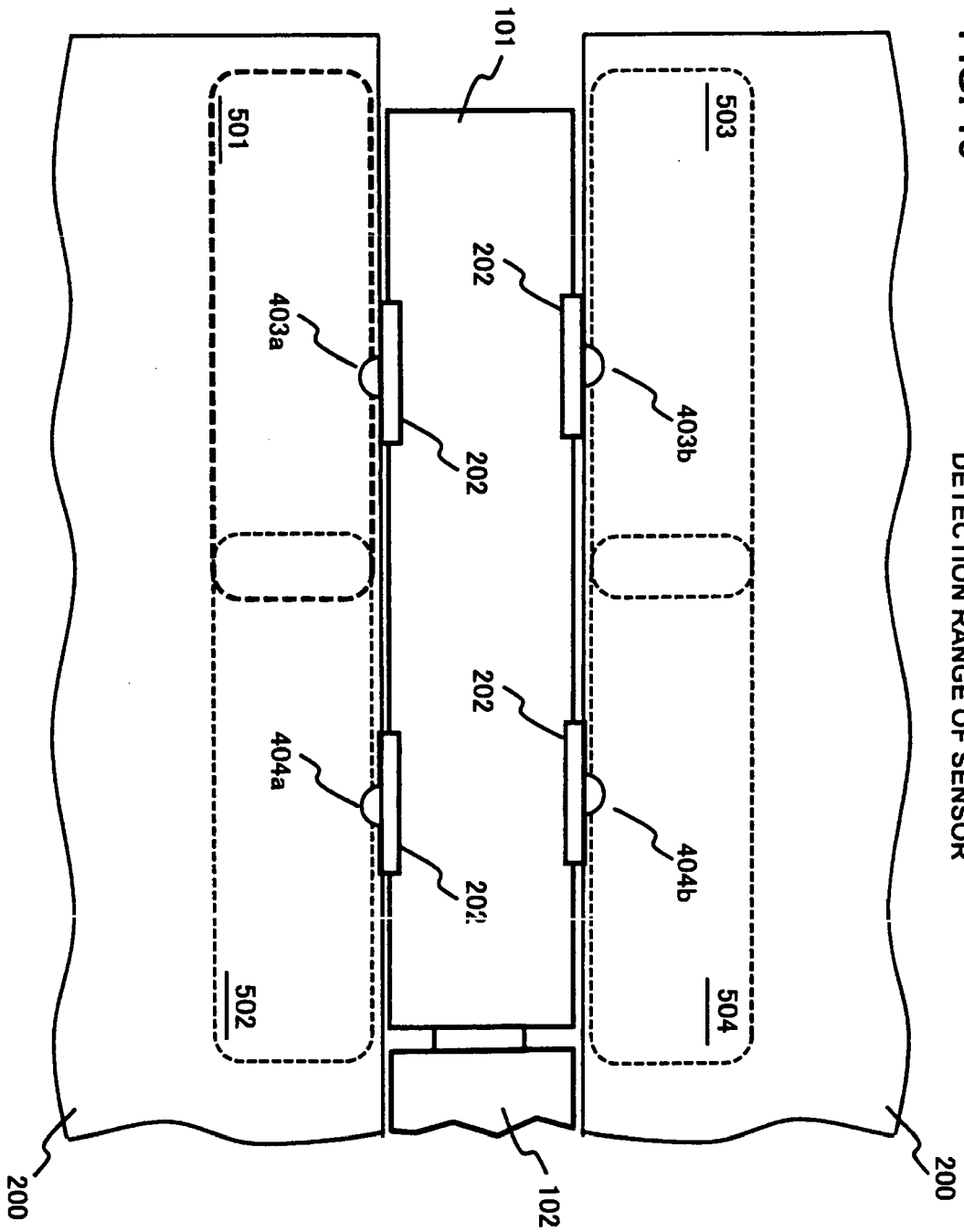


FIG. 16

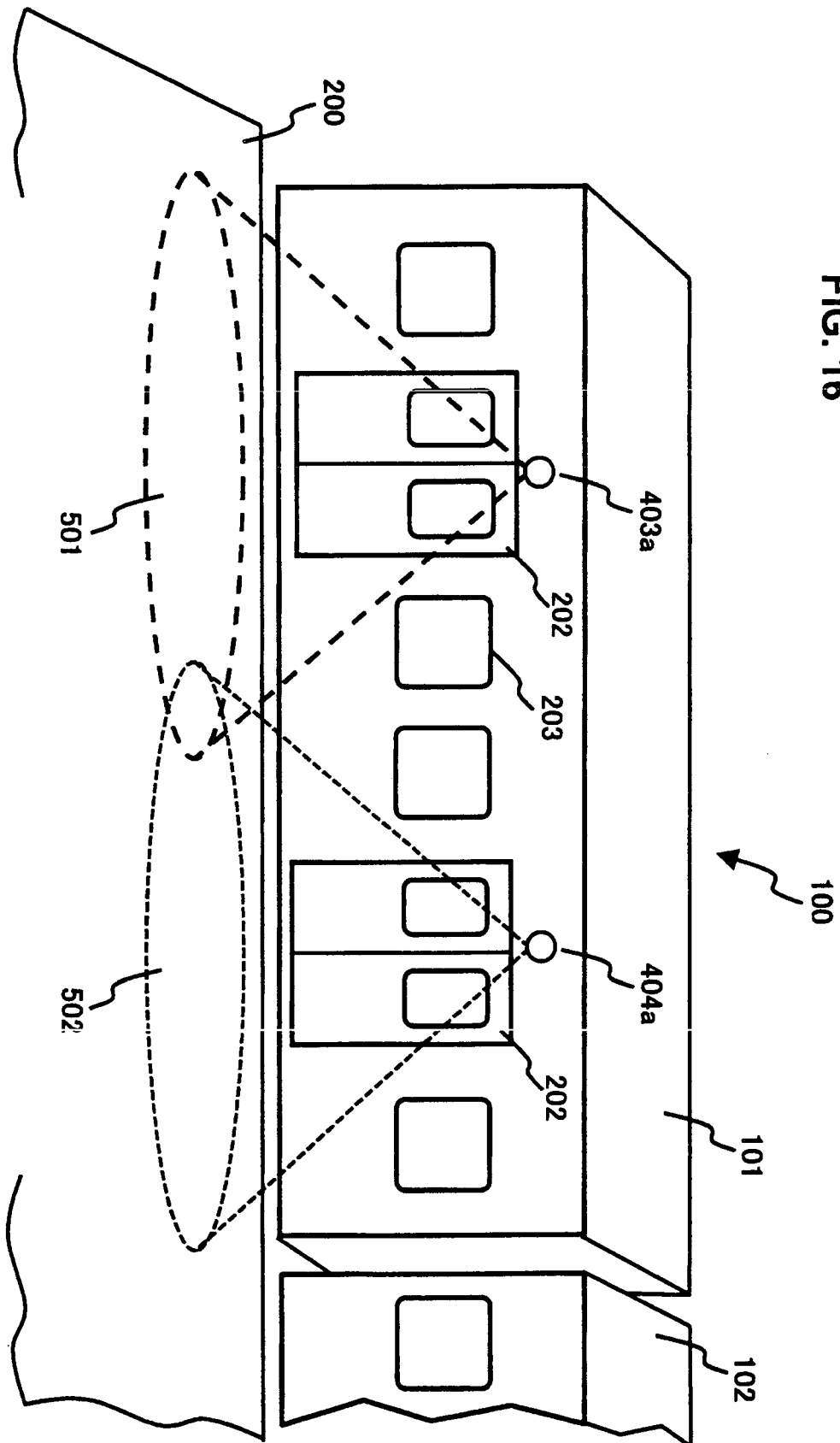
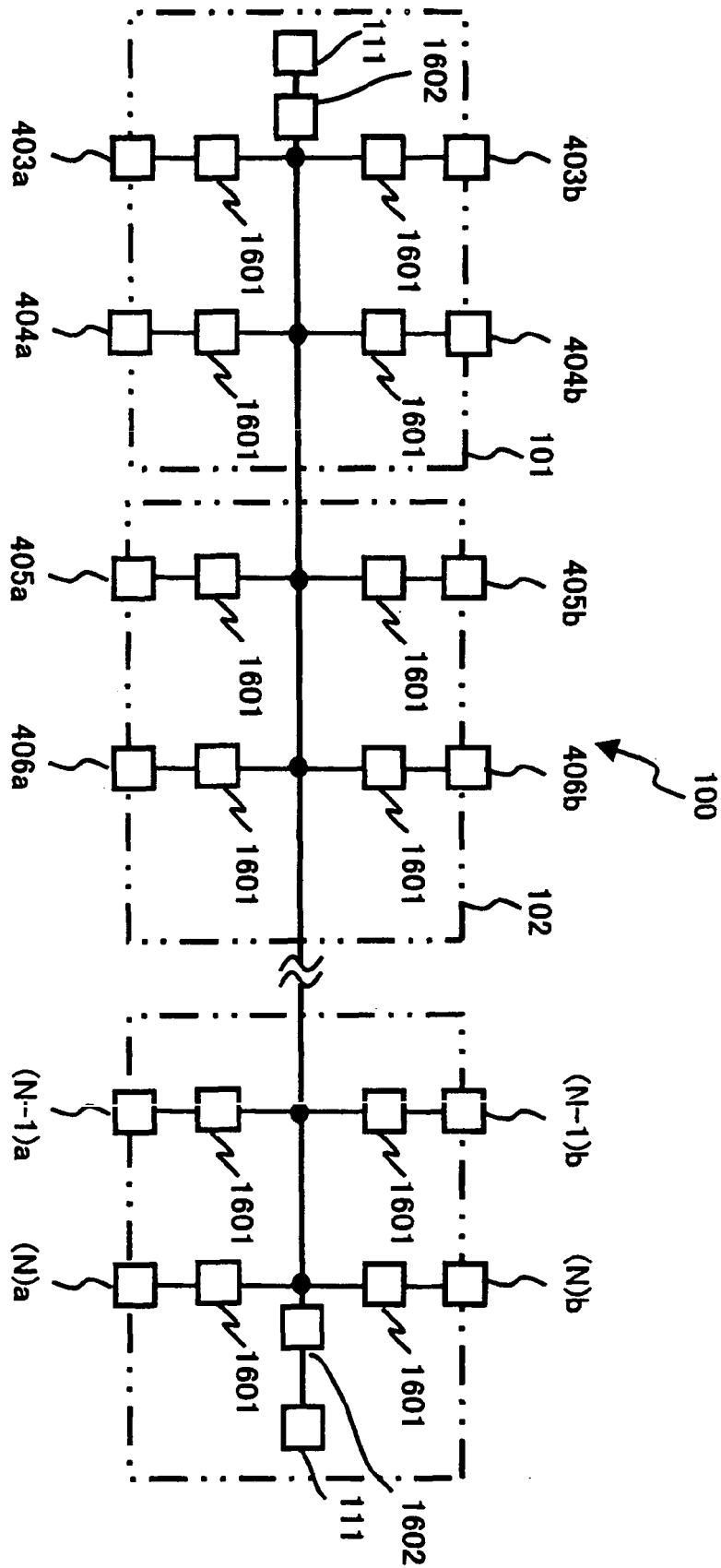


FIG. 17





EUROPEAN SEARCH REPORT

Application Number
EP 10 25 2104

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	WO 2004/078552 A1 (LORENZ WALTER [AT]) 16 September 2004 (2004-09-16) * pages 15,16; figures 1,2 *	1-3,6	INV. B61K13/04
X	EP 1 382 506 A1 (SAFECOM ENGINEERING AG [CH]) 21 January 2004 (2004-01-21) * figures 2,4 *	1	
			TECHNICAL FIELDS SEARCHED (IPC)
			B61B B61K B61D
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 28 September 2011	Examiner Lorandi, Lorenzo
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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EP 10 25 2104

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28-09-2011

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2004078552 A1	16-09-2004	AT 500925 A1	15-04-2006
		EP 1599373 A1	30-11-2005

EP 1382506 A1	21-01-2004	NONE	

REFERENCES CITED IN THE DESCRIPTION

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- JP 2002104189 A [0002]
- WO 2007015446 A [0004]