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Kinugawa

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(54) **TRANSPORT FACILITY**

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B61B 13/12 (2006.01)
B65G 43/02 (2006.01)
B65G 47/64 (2006.01)

(52) **U.S. Cl.**
CPC ***B65G 35/06*** (2013.01); ***B61B 13/12*** (2013.01); ***B65G 43/02*** (2013.01); ***B65G 47/64*** (2013.01); *B65G 2203/0283* (2013.01)

(58) **Field of Classification Search**
CPC B65G 35/06; B65G 43/02; B65G 47/641; B65G 54/02; B61B 13/12
USPC 198/465.1, 370.03
See application file for complete search history.

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(57) **ABSTRACT**

A travel route of a transport facility includes a guide zone in which a guide rail is disposed and a non-guide zone in which the guide rail is not disposed. A control system causes a guide drive section to execute a confirmation operation to drive a first guided section in a width direction Y in response to occurrence of a specific event in which a transport vehicle loses information on a travel position thereof, determines that the transport vehicle is in the non-guide zone in response to the first guided section moving from a first position to a second position or from the second position to the first position, and determines that the transport vehicle is in the guide zone in response to the first guided section being prevented from moving from the first position to the second position or from the second position to the first position.

6 Claims, 4 Drawing Sheets

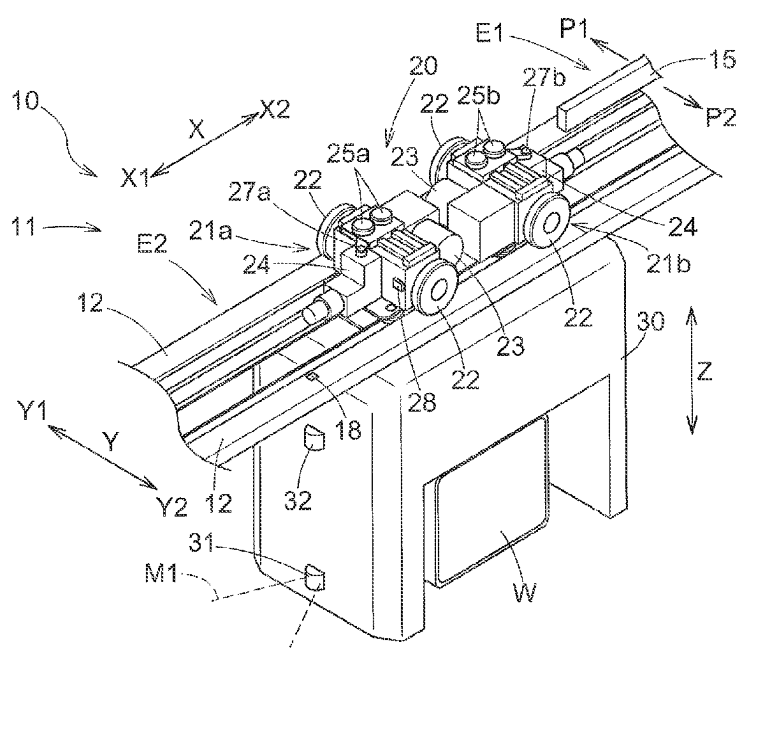
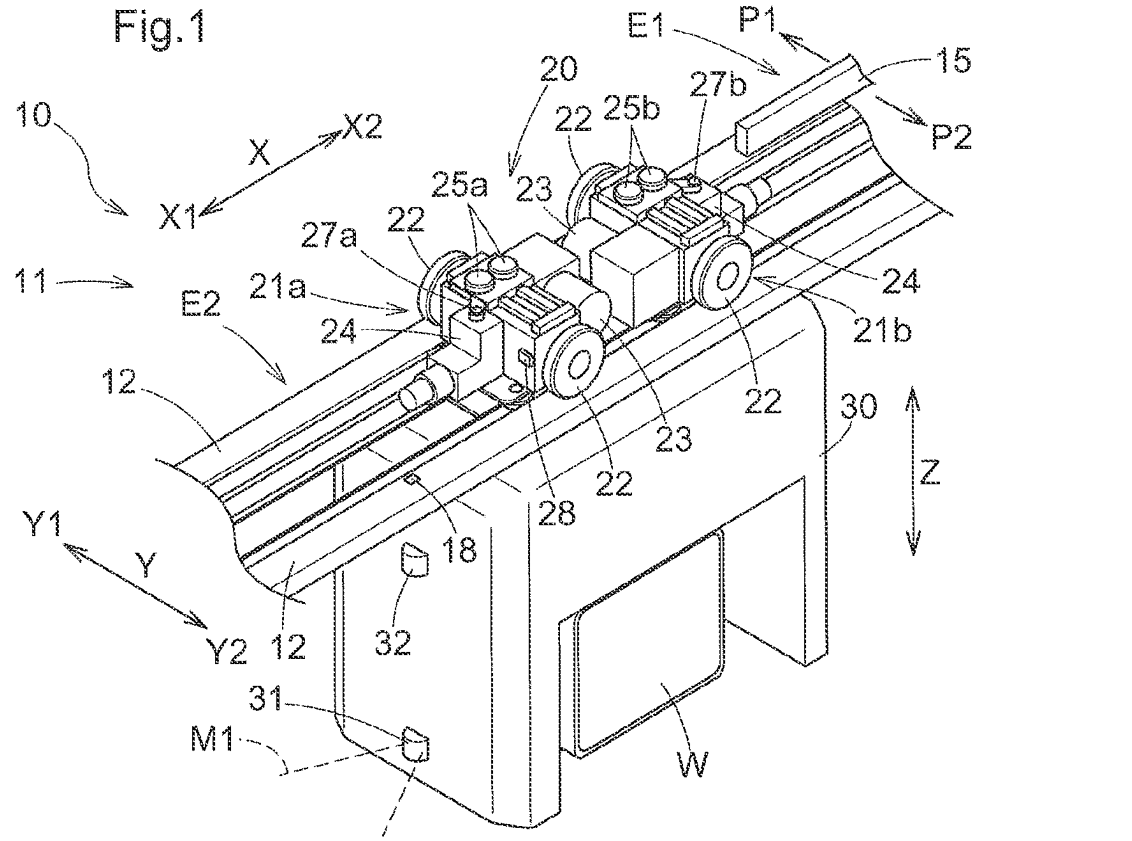
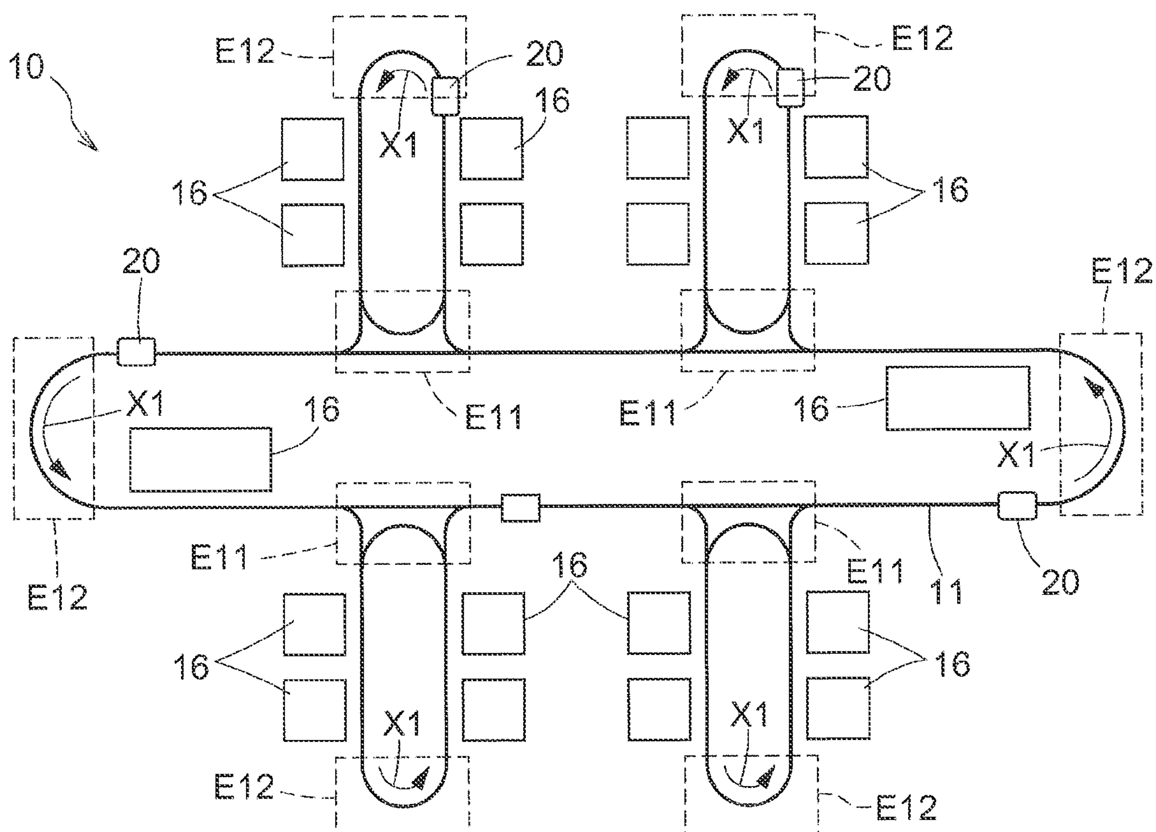


Fig.1



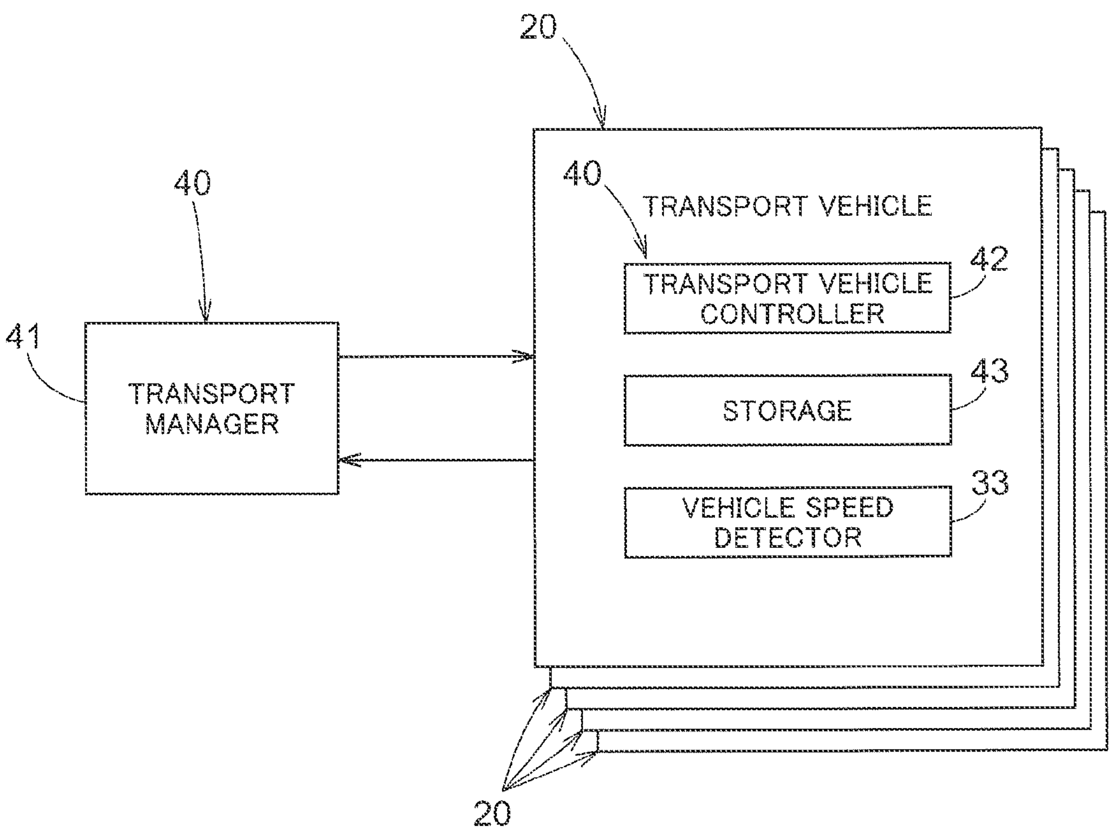
10
X
X1
X2
11
E1
P1
15
P2
20
22
25b
27b
25a
23
27a
21a
24
21b
E2
12
30
Z
28
18
Y1
Y
Y2
32
31
M1
W

Fig.2



10
E12
20
16
X1
E11
11

Fig.3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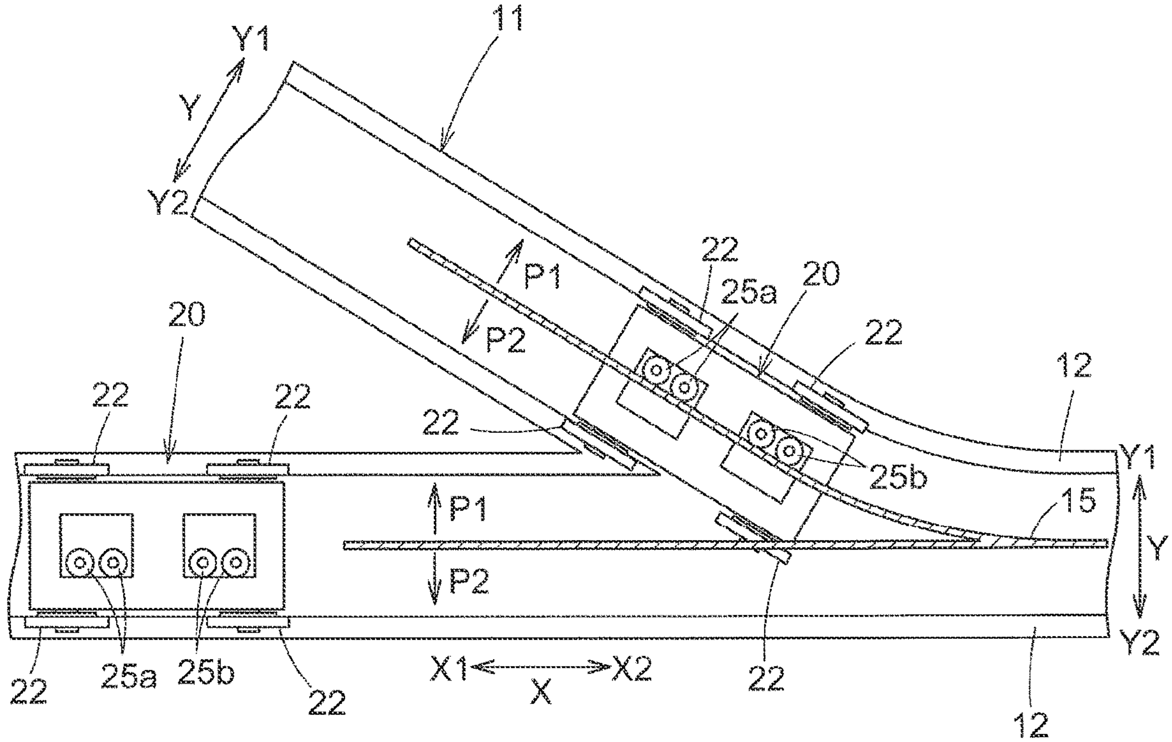
40
TRANSPORT VEHICLE
TRANSPORT VEHICLE CONTROLLER
42
STORAGE
43
VEHICLE SPEED DETECTOR
33
40
41
TRANSPORT MANAGER
20

Fig.4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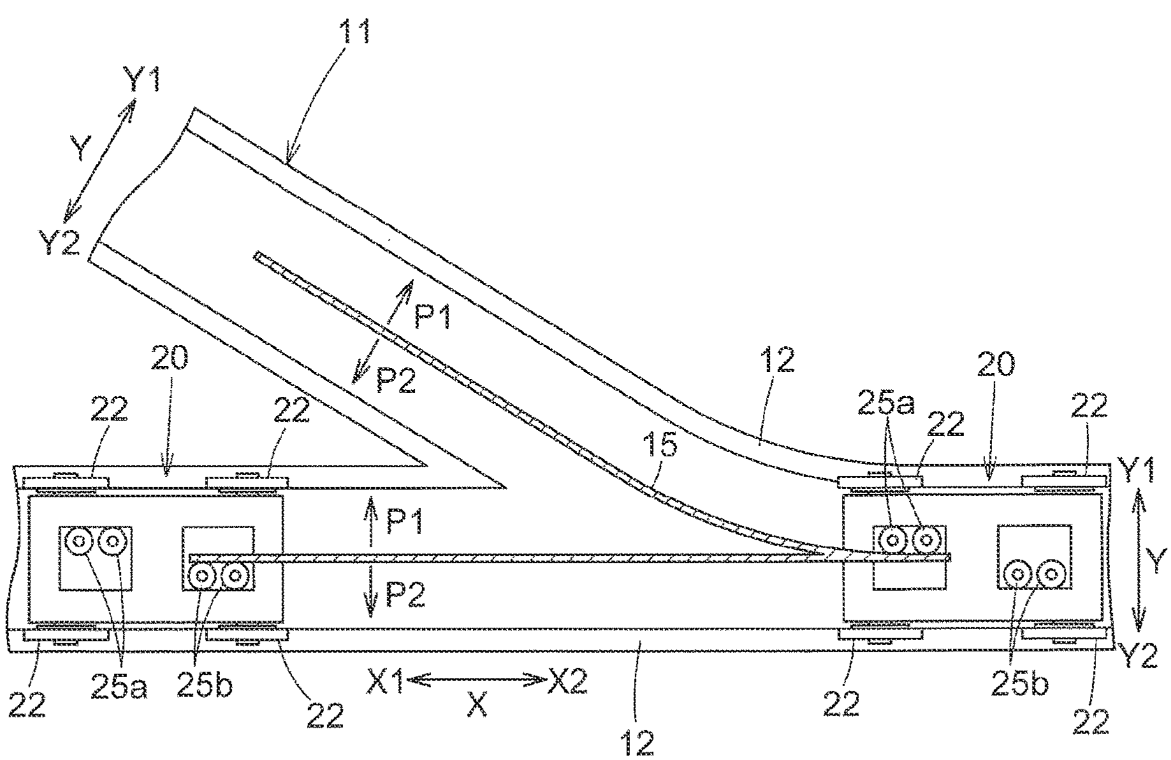
22
12

Fig.5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25b
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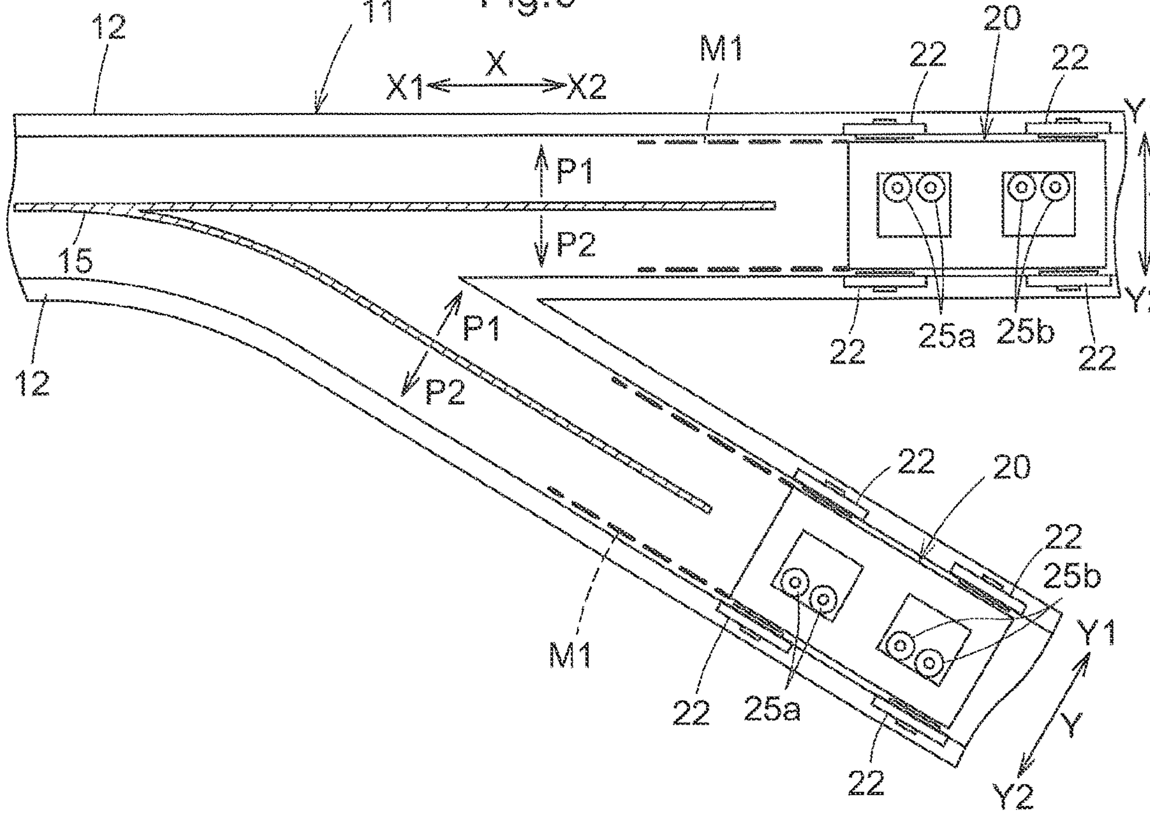
12

Fig.6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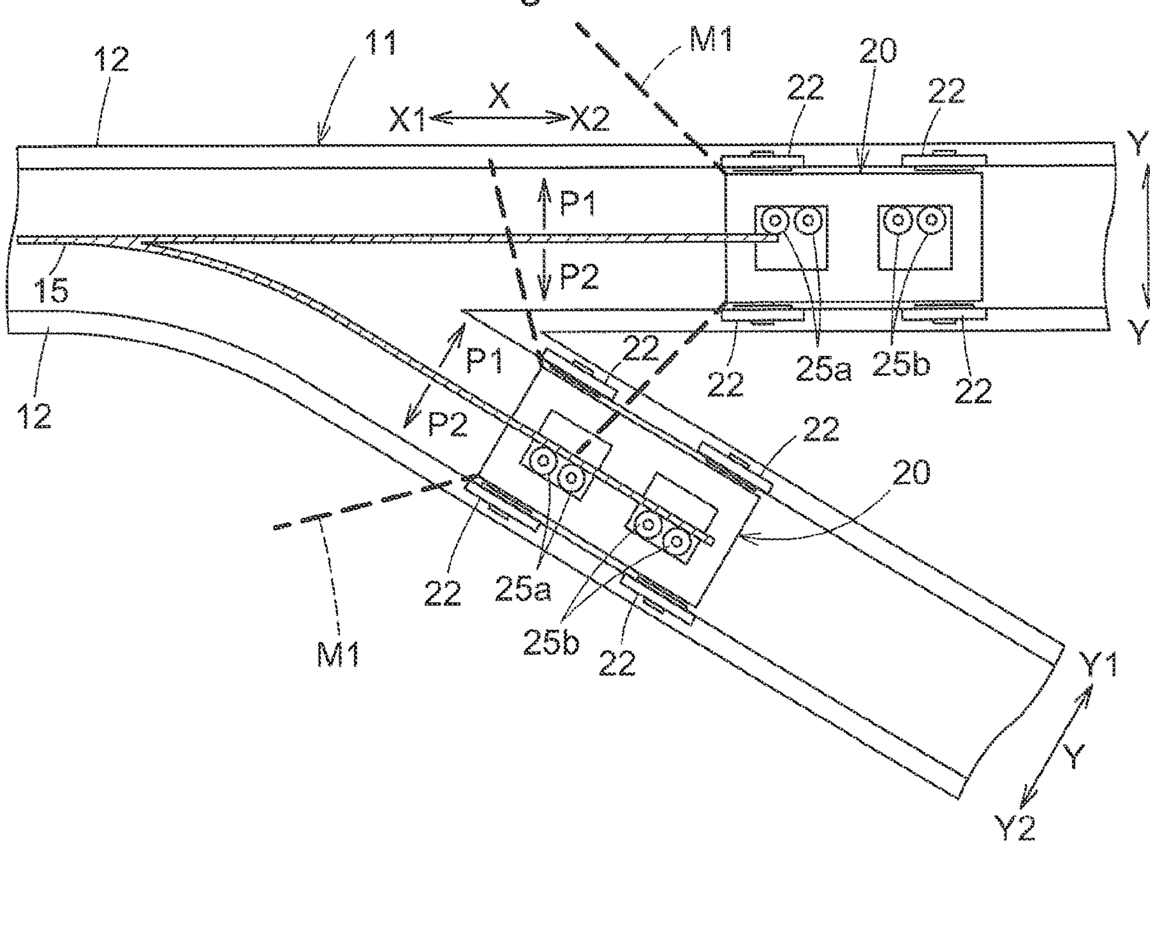
Y
22
Y2

Fig.7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P1
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P1
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25a
25b
22
P2
22
20
22
25a
M1
25b
22
Y1
Y
Y2

TRANSPORT FACILITY

CROSS-REFERENCE TO RELATED APPLICATION

This application claims priority to Japanese Patent Application No. 2023-023371 filed Feb. 17, 2023, the disclosure of which is hereby incorporated by reference in its entirety.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a transport facility including a transport vehicle that travels along a travel route, and a control system that controls the transport vehicle.

2. Description of Related Art

One example of such a transport facility is described in JP 2019-080411A. The reference signs in parentheses below in "Description of Related Art" are those used in this patent document. In this transport facility, a positional information reading section (23) of a transport vehicle (3) reads positional information of position display devices (26) that are at intervals along rails (2), so that the transport vehicle obtains information on the travel position, and a control system (H) controls the transport vehicle based on the obtained information.

SUMMARY OF THE INVENTION

Such a control system that controls a transport vehicle has to properly control the transport vehicle according to, for example, the shape of a travel route such as whether there are branch or merge parts or whether the route is straight or curved, the positions of various facilities at which the transport vehicle is stopped, and the like. However, in this kind of transport facility, for example, in the case in which a specific event such as a power failure in which a transport vehicle loses information on its travel position has occurred, the transport vehicle has lost information on its travel position, and thus it is difficult for the control system to properly resume control of the transport vehicle unless a worker performs a restoration work or the like to make the transport vehicle recognize its travel position.

Therefore, it is desirable to realize a transport facility in which a control system can properly resume control of a transport vehicle even if a specific event in which the transport vehicle loses information on its travel position occurs.

The present disclosure is directed to a transport facility including: a transport vehicle configured to travel along a travel route; a guide rail along the travel route; and a control system configured to control the transport vehicle, wherein, with a travel direction being a direction along the travel route, a width direction being a direction orthogonal to the travel direction in a vertical view, a first side in the width direction being one side in the width direction, and a second side in the width direction being another side in the width direction, the transport vehicle includes: a guided section configured to be guided by the guide rail; and a guide drive section configured to drive the guided section in the width direction to move the guided section to a first position on the first side in the width direction of the guide rail and to a second position on the second side in the width direction of the guide rail, the travel route includes a guide zone in which the guide rail is disposed and a non-guide zone in which the guide rail is not disposed, and, in response to occurrence of a specific event in which the transport vehicle loses information on a travel position thereof, the control system (i) causes the guide drive section to execute a confirmation operation to drive the guided section in the width direction, (ii) determines that the transport vehicle is in the non-guide zone in response to the guided section moving from the first position to the second position or from the second position to the first position in the confirmation operation, and (iii) determines that the transport vehicle is in the guide zone in response to the guided section being prevented from moving from the first position to the second position or from the second position to the first position in the confirmation operation.

This configuration makes it possible to determine whether a transport vehicle is in the guide zone or the non-guide zone, through a confirmation operation to drive the guided section in the width direction, even if a specific event in which the transport vehicle loses information on its travel position occurs. Accordingly, the control system can cause the transport vehicle to perform proper control according to whether the transport vehicle is in the guide zone or the non-guide zone. Therefore, the control system can properly resume control of the transport vehicle, even if a specific event in which the transport vehicle loses information on its travel position occurs.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a transport facility according to an embodiment.

FIG. **2** is a top view of travel routes in FIG. **1**.

FIG. **3** is a control block diagram of the transport facility in FIG. **1**.

FIG. **4** is a view illustrating a confirmation operation in an intersection zone shown in FIG. **2**.

FIG. **5** is a view showing a state during the confirmation operation in the intersection zone in FIG. **4**.

FIG. **6** is a view showing a state immediately before two transport vehicles enter the intersection zone shown in FIG. **2**.

FIG. **7** is a view showing a state in which the two transport vehicles shown in FIG. **6** are traveling in the intersection zone.

DESCRIPTION OF THE INVENTION

An embodiment of a transport facility will be described below with reference to the drawings.

As shown in FIG. **1**, a transport facility **10** includes a transport vehicle **20** that travels along a travel route **11** and a guide rail **15** along the travel route **11**. The transport facility **10** in this embodiment has a plurality of transport vehicles **20**. The transport vehicles **20** in this embodiment are overhead transport vehicles. The transport vehicles **20** are motorized unmanned transport vehicles. The transport vehicles **20** transport, for example, FOUPs (Front Opening Unified Pods) containing semiconductor substrates, as articles W. The transport facility **10** in this embodiment is indoors, for example, in a clean room.

A travel direction X is a direction along the travel route **11**. An up-down direction Z is a vertical direction. A width direction Y is a direction orthogonal to the travel direction X in a vertical view. A first side Y**1** in the width direction is one side in the width direction Y, and a second side Y**2** in the width direction is the other side in the width direction Y. The travel route **11** in this embodiment has travel rails **12** along which the transport vehicles **20** travel. The travel rails **12** are a pair of rails on both sides in the width direction Y. The travel rails **12** are suspended from the ceiling.

Such travel routes **11** in this embodiment include guide zones E**1** in which the guide rail **15** is disposed and non-guide zones E**2** in which the guide rail **15** is not disposed. The guide rail **15** in the example shown in the drawing is along the center in the width direction Y of the travel routes **11**. The guide rail **15** is between the pair of travel rails **12** in a vertical view. The guide rail **15** is suspended from the ceiling.

FIG. **2** is a view showing an example of the travel routes **11**. Facilities **16** such as processing devices for the articles W, article placement tables, article storage racks, and other various devices are outside in the width direction Y of the travel routes **11** in this embodiment. The transport vehicles **20** in the example shown in FIG. **2** travel in one direction along the travel routes **11**. A forward side X**1** is a side in an advancing direction of the transport vehicles **20** along the travel direction X, and a rearward side X**2** is a side opposite to the advancing direction.

The guide rail **15** in this embodiment is in at least either intersection zones E**11**, in which travel routes **11** intersect each other, or curved zones E**12**, in which a travel route **11** is curved. The intersection zones E**11** may be, for example, a branch zone, a merge zone, a cross intersection zone, or an N-shaped branch-merge zone. The curved zones E**12** may be, for example, a U-shaped, S-shaped, or C-shaped zone, or other curved travel zones. The intersection zones E**11** in the example shown in the drawing are branch zones and merge zones. A branch zone may be, for example, a zone in which one travel route **11** branches into a plurality of travel routes **11**. A merge zone may be, for example, a zone in which a plurality of travel routes **11** merge into one travel route **11**. The guide rail **15** is configured to guide the course of the transport vehicles **20** in the branch zones and the merge zones in this embodiment.

Returning to FIG. **1**, each transport vehicle **20** in this embodiment includes a first travel section **21***a* that travels along the travel routes **11**. The first travel section **21***a* in this embodiment includes wheels **22** that roll on the rail surfaces of the travel routes **11** and a drive section **23** for traveling that rotates the wheels **22**. The drive section **23** for traveling may be, for example, an electric motor such as a servomotor, or an internal combustion engine. The rail surfaces of the travel routes **11** on which the wheels **22** roll are upward-facing faces of the travel rails **12**, and the wheels **22** rotate around an axis orthogonal to the up-down direction Z.

The transport vehicle **20** includes first guided sections **25***a* that are guided by the guide rail **15**. The first guided sections **25***a* in this embodiment roll on a guide face of the guide rail **15**. The guide face of the guide rail **15** is a face facing one side in the width direction Y, and the first guided sections **25***a* rotate around axes along the up-down direction Z. The first guided sections **25***a* are on the first travel section **21***a*. The first guided sections **25***a* are two sections that are side by side in the travel direction X. The first guided sections **25***a* correspond to the "guided section".

The transport vehicle **20** includes a guide drive section **24** that drives the first guided sections **25***a* in the width direction Y to move the guided sections to a first position P**1** on the first side Y**1** in the width direction of the guide rail **15** and to a second position P**2** on the second side Y**2** in the width direction of the guide rail **15**. The guide drive section **24** may be, for example, a solenoid actuator, an electric motor, or a hydraulic system. The guide drive section **24** in this embodiment executes a course selecting operation to switch the position of the first guided sections **25***a* according to the course of the transport vehicle **20** before the transport vehicle enters the guide zones E**1**. For example, if the transport vehicle **20** enters the branch zone shown in FIG. **4**, the transport vehicle **20** advances to a branch on the first side Y**1** in the width direction (the right side with respect to the advancing direction) in response to switching of the position of the first guided sections **25***a* to the first position P**1**, and the transport vehicle **20** advances to a branch on the second side Y**2** in the width direction (the left side with respect to the advancing direction) in response to switching of the position of the first guided sections **25***a* to the second position P**2**.

The transport vehicle **20** in this embodiment includes, in addition to the first guided sections **25***a*, second guided sections **25***b* on the rearward side X**2** in the travel direction X of the first guided sections **25***a*. The guide drive section **24** drives the first guided sections **25***a* and the second guided sections **25***b* independently of each other in the width direction Y. The guide drive section **24** executes a course selecting operation to switch the positions in the width direction Y of the first guided sections **25***a* and the second guided sections **25***b* independently of each other according to the course of the transport vehicle **20** before the transport vehicle enters the guide zones E**1**.

The transport vehicle **20** in this embodiment includes a second travel section **21***b* on the rearward side X**2** in the travel direction X of the first travel section **21***a*. The second travel section **21***b* includes wheels **22** that roll on the rail surfaces of the travel routes **11** and a drive section **23** for traveling that rotates the wheels **22**. The second travel section **21***b* in this embodiment includes the second guided sections **25***b*. The second guided sections **25***b* are two sections that are side by side in the travel direction X. The first guided sections **25***a* and the second guided sections **25***b* in the example shown in the drawing are guide wheels. The first guided sections **25***a* and the second guided sections **25***b* in the example shown in the drawing are guide wheels with the same diameter.

The transport vehicle **20** in this embodiment includes a body section **30** connected to the first travel section **21***a*. The body section **30** is on the lower side in the up-down direction Z of the first travel section **21***a*, and is supported by the first travel section **21***a*. The body section **30** is connected to the second travel section **21***b* as well. The body section **30** is on the lower side of the first travel section **21***a* and the second travel section **21***b*, and is supported by the first travel section **21***a* and the second travel section **21***b*. The body section **30** includes a transfer device (not shown) that transfers the articles W to a transport destination. The articles W are transported by the transport vehicle **20** with the transfer device being at a predetermined travel position.

The transport vehicle **20** in this embodiment includes a first detecting section **27***a* configured to detect movement in the width direction Y of the first guided sections **25***a*. The first detecting section **27***a* detects whether or not the first guided sections **25***a* have moved from the first position P**1** to the second position P**2** or from the second position P**2** to the first position P**1**. The first detecting section **27***a* in this embodiment can detect whether or not the first guided sections **25***a* are at the first position P**1**. The first detecting section **27***a* can detect whether or not the first guided sections **25***a* are at the second position P**2**. The first detecting section **27***a* may be, for example, an optical sensor or a laser sensor. The transport vehicle **20** in this embodiment includes a second detecting section **27***b* configured to detect movement in the width direction Y of the second guided sections **25***b*. The second detecting section **27***b* has a configuration similar to that of the first detecting section **27***a*. Detection results of the first detecting section **27***a* and the second detecting section **27***b* are transmitted to a later-described control system **40**.

A plurality of information holders **18** holding positional information on positions thereof are respectively at a plurality of points along the travel routes **11** in this embodiment. The information holders **18** in this embodiment are at intervals along the travel routes **11**. The information holders **18** may be, for example, a one-dimensional bar code, a two-dimensional bar code, a number, text, an image marking, or a radio tag. The information holders **18** are, for example, on the travel rails **12**, the guide rail **15**, holding members holding the travel rails **12** or the guide rail **15**, or the rail surfaces.

The transport vehicle **20** in this embodiment further includes a reader **28** configured to read the positional information of the information holders **18** and recognize a travel position of the transport vehicle based on the information read by the reader **28**. The reader **28** may be, for example, a bar code reader, an image recognition device, a character recognition device that recognizes numbers and letters, or a wireless identification device.

The transport vehicle **20** in this embodiment further includes an obstacle sensor **31** configured to detect an obstacle on the forward side X**1** in the travel direction X. The transport vehicle **20** slows down or stops, for example, in response to detection of an obstacle by the obstacle sensor **31** during travel of the transport vehicle **20**. The obstacle sensor **31** can change a detection range M**1**. The obstacle may be, for example, workers, work robots, foreign objects, or other transport vehicles **20** on the travel routes **11**. The obstacle sensor **31** may be, for example, an optical sensor, an ultrasonic sensor, an image sensor, a millimeter wave sensor, or a laser sensor. Detection results by the obstacle sensor **31** are transmitted to a later-described control system **40**. Changing the detection range M**1** may be performed by changing the detection range of a single obstacle sensor **31**, or by switching a plurality of obstacle sensors **31** aligned in the width direction Y or the up-down direction Z on and off individually. The obstacle sensor **31** in this embodiment can project light toward the forward side X**1** in the travel direction X and measure the distance to the obstacle based on reflected light. The obstacle sensor **31** is on a front face of the transport vehicle **20**. The obstacle sensor **31** is on a front face of the body section **30**.

The transport vehicle **20** in this embodiment includes a rear-end collision prevention sensor **32** configured to detect another transport vehicle **20** on the forward side X**1** in the travel direction X. The rear-end collision prevention sensor **32** may be, for example, an optical sensor, an ultrasonic sensor, an image sensor, a millimeter wave sensor, or a laser sensor. The rear-end collision prevention sensor **32** is closer to the travel rails **12** in the up-down direction Z than the obstacle sensor **31** on the front face of the transport vehicle **20** is. The rear-end collision prevention sensor **32** in this embodiment is configured to project light toward the forward side X**1** in the travel direction X and detect reflections by a reflective member on a face on the rearward side X**2** of another transport vehicle **20**. The rear-end collision prevention sensor **32** is on the front face of the body section **30**.

FIG. **3** is a control block diagram of the transport facility **10**. The transport facility **10** in this embodiment includes vehicle speed detectors **33** that detect travel speeds of the transport vehicles **20**. The vehicle speed detectors **33** are on the transport vehicles **20**. The vehicle speed detectors **33** detect travel speeds of the transport vehicles **20** by measuring rotational speeds of the pairs of wheels **22**.

The transport facility **10** includes a control system **40** that controls the transport vehicles **20**. The control system **40** in this embodiment controls the first travel sections **21***a* and the second travel sections **21***b* of the transport vehicles **20** and the transfer devices of the body sections **30**. The functions of the control system **40** are realized, for example, through cooperation between hardware such as an arithmetic processor and a program executed on the hardware. All of the control system **40** may be in the transport vehicles **20**, or part of the control system may be in control devices in the transport vehicles **20** and part of the control system may be in an external control device such as that in a centralized control room. All of the control system **40** may be in an external control device. The control system **40** in this embodiment includes an external transport manager (material control processor) **41** and transport vehicle controllers **42** respectively on the plurality of transport vehicles **20**. The transport manager **41** and the transport vehicle controllers **42** are configured for wireless communication. The control system **40** in this embodiment includes storages **43** that can store information obtained by the readers **28**. The storages **43** in the example shown in FIG. **3** are in the transport vehicles **20**, but may be in the transport manager **41** or the transport vehicle controllers **42**.

The control system **40** causes the guide drive sections **24** to execute a confirmation operation to drive the first guided sections **25***a* in the width direction Y in response to occurrence of a specific event in which the transport vehicles **20** lose information on their travel positions. The specific event in which the transport vehicles lose information on their travel positions may be, for example, a power failure, updating of control software from a higher-level controller, abnormal stop, power interruption by a worker, or travel of the transport vehicles **20** after a failure or power interruption. The confirmation operation in this embodiment is executed while the transport vehicles **20** are stopped. In this embodiment, in the event of a power failure, the power supply is cut off and the transport vehicles **20** are stopped. The control system **40** may execute stop processing that stops the transport vehicles **20** at predetermined positions in response to occurrence of the specific event.

The control system **40** determines that a transport vehicle **20** is in a non-guide zone E**2** in response to the first guided sections **25***a* moving from the first position P**1** to the second position P**2** or from the second position P**2** to the first position P**1** in the confirmation operation. The control system **40** determines that a transport vehicle **20** is in a guide zone E**1** in response to the first guided sections **25***a* being prevented from moving from the first position P**1** to the second position P**2** or from the second position P**2** to the first position P**1** during the confirmation operation. The control system **40** may be configured to determine whether a transport vehicle **20** is in a guide zone E**1** or a non-guide zone E**2** not through the confirmation operation to drive the first guided sections **25***a* in the width direction Y but through a confirmation operation to detect the guide rail **15** using a sensor or the like.

FIG. **4** is a top view of a branch zone in an intersection zone E**11**. For example, the transport vehicle **20** on the rearward side X**2** in the travel direction X in FIG. **4** has the first guided sections **25***a* and the second guided sections **25***b* at the first position P**1**, and the first guided sections **25***a* and the second guided sections **25***b* are prevented by the guide rail **15** from moving in the confirmation operation to drive these guided sections to the second position P**2**. Accordingly, the control system **40** determines that the transport vehicle **20** is in the guide zone E**1**. The transport vehicle **20** on the forward side X**1** in the travel direction X in FIG. **4** has the first guided sections **25***a* and the second guided sections **25***b* at the second position P**2**, and the first guided sections **25***a* and the second guided sections **25***b* move to the first position P**1** in the confirmation operation to drive the first guided sections **25***a* and the second guided sections **25***b* to the first position P**1** because the movement is not prevented by the guide rail **15**. Accordingly, the control system **40** determines that the transport vehicle **20** is in the non-guide zone E**2**. In this case, the control system **40** executes a post-determination return operation to return the first guided sections **25***a* and the second guided sections **25***b* to the original position (the second position P**2**).

The control system **40** in this embodiment executes the confirmation operation on both the first guided sections **25***a* and the second guided sections **25***b* in response to occurrence of the specific event. The control system **40** determines that the transport vehicle **20** is in the non-guide zone E**2** in response to both the first guided sections **25***a* and the second guided sections **25***b* moving from the first position P**1** to the second position P**2** or from the second position P**2** to the first position P**1** in the confirmation operation. The control system **40** determines that the transport vehicle **20** is in the guide zone E**1** in response to at least either the first guided sections **25***a* or the second guided sections **25***b* being prevented from moving from the first position P**1** to the second position P**2** or from the second position P**2** to the first position P**1** in the confirmation operation.

FIG. **5** is a view showing a state during the confirmation operation in the branch zone in the intersection zone E**11**. For example, the drawing shows a state in which two transport vehicles **20** shown in FIG. **5** have only the first guided sections **25***a* or the second guided sections **25***b* that have moved from the first position P**1** to the second position P**2** or from the second position P**2** to the first position P**1** in the confirmation operation. Accordingly, the control system **40** determines that both of the transport vehicles **20** are in the guide zone E**1**. In this case, the control system **40** executes the post-determination return operation to return the first guided sections **25***a* and the second guided sections **25***b* that have moved in the confirmation operation to the original position, which is the position before the confirmation operation.

The control system **40** may be configured to determine that a transport vehicle **20** is in a non-guide zone E**2** in response to the first guided sections **25***a* moving from the first position P**1** to the second position P**2** or from the second position P**2** to the first position P**1** as in the case of the transport vehicle **20** on the forward side X**1** in the travel direction X shown in FIG. **5**. That is to say, in the case in which a transport vehicle **20** includes a plurality of guided sections, the control system **40** may be configured to determine that the transport vehicle **20** is in a non-guide zone E**2** in response to the guided section on the most forward side X**1** in the travel direction X moving from the first position P**1** to the second position P**2** or from the second position P**2** to the first position P**1**.

FIG. **6** is a view showing a state immediately before two transport vehicles **20** enter a merge zone. FIG. **7** is a view showing a state in which two transport vehicles **20** are traveling in the merge zone. The control system **40** in this embodiment sets the detection range M**1** of the obstacle sensor **31** wider in response to determining that the transport vehicle is in the guide zone E**1** than in response to determining that the transport vehicle is in the non-guide zone E**2** as a result of the confirmation operation. In this embodiment, the detection range M**1** in the width direction Y of the obstacle sensor **31** is set wider. This change of setting is preferably performed by the control system **40** before later-described restoration processing.

In this embodiment, the detection range M**1** in the width direction Y of the obstacle sensor **31** in the non-guide zones E**2** is the range in which the facilities **16** (see FIG. **2**) outside in the width direction Y of the travel routes **11** are not detected. The facilities **16** are outside the detection range M**1** in the width direction Y of the obstacle sensor **31**, in the guide zones E**1**.

In the example shown in FIG. **6**, the control system **40** sets the detection ranges M**1** to the ranges in the width direction Y corresponding to the travel paths on the forward side X**1** in the travel direction X of the transport vehicles **20** in response to determining that the transport vehicles **20** are in the non-guide zone E**2** as a result of the confirmation operation. Accordingly, the facilities **16** that are not obstacles in the non-guide zone E**2** are not detected as obstacles. However, if the two transport vehicles **20** are subjected to later-described restoration processing and allowed to travel with the detection ranges M**1** being still the ranges shown in FIG. **6**, there is a possibility that the obstacle sensors **31** of the transport vehicles **20** cannot detect each other and the transport vehicles collide with each other. In the example shown in FIG. **7**, if it is determined that the transport vehicles **20** are in the guide zone E**1**, the detection ranges M**1** are set to the ranges in which other transport vehicles **20** on the forward side X**1** and the lateral sides in the travel direction X can be detected. Accordingly, the obstacle sensor **31** of at least one transport vehicle **20** is more likely to detect the other transport vehicle **20**. Also, the detection ranges M**1** in the width direction Y of the obstacle sensors **31** are set wider in the curved zone E**12**, and thus obstacles on the travel routes such as other transport vehicles **20** can be detected at an early stage.

The control system **40** in this embodiment executes restoration processing to allow a transport vehicle **20** to start traveling after the specific event is resolved. The restoration processing may be ended by the control system **40**, for example, after the transport vehicle **20** reads positional information of an information holder **18** (shown in FIG. **1**). The restoration processing may be ended by the control system **40**, for example, after the transport vehicle **20** reads the positional information of information holders **18** a plurality of times. The control system **40** in this embodiment executes normal processing after the restoration processing is ended. The normal processing is, for example, processing that transports or transfers the articles W based on information from outside the transport vehicle **20** (e.g., commands from the transport manager **41**). In this embodiment, the control system **40** ends the restoration processing after the transport vehicle **20** reads the positional information of the information holder **18** and the transport manager **41** of the control system **40** is restarted, but the control system **40** may end the restoration processing immediately after the transport vehicle **20** reads the positional information of the information holder **18**.

The control system **40** in the restoration processing in this embodiment causes the transport vehicle **20** to travel at or below a predetermined first speed limit V**1** for restoration from when the stopped transport vehicle **20** starts traveling to when the transport vehicle **20** reads the positional information of the information holder **18** (shown in FIG. **1**). The control system **40** in restoration processing in this embodiment causes the transport vehicle **20** to travel at or below the first speed limit V**1** for restoration in response to determining that the transport vehicle **20** is in a non-guide zone E**2** as a result of the confirmation operation, and causes the transport vehicle **20** to travel at or below a second speed limit V**2** for restoration, which is lower than the first speed limit V**1** for restoration in response to determining that the transport vehicle **20** is in a guide zone E**1** as a result of the confirmation operation.

The control system **40** in this embodiment causes a plurality of transport vehicles **20** on which a specific event has occurred to simultaneously execute the confirmation operation in response to occurrence of the specific event on the plurality of transport vehicles **20** on the travel routes **11**. In this embodiment, restoration processing (described later) is executed on the plurality of transport vehicles **20** after the confirmation operation. The confirmation operation that is simultaneously executed on the plurality of transport vehicles **20** does not have to be executed at exactly the same time. For example, the restoration processing may be executed on a plurality of transport vehicles **20** determined as being in the guide zones E**1** after the restoration processing is executed on a plurality of transport vehicles **20** determined as being in the non-guide zones E**2**. The restoration processing may be executed on a plurality of transport vehicles **20** determined as being in the non-guide zones E**2** after the restoration processing is executed on a plurality of transport vehicles **20** determined as being in the guide zones E**1**. The restoration processing may be executed only on transport vehicles **20** that meet a predetermined travel condition out of a plurality of transport vehicles **20**. The predetermined travel condition may be, for example, that the transfer device in the body section **30** is at a predetermined travel position, that the transport vehicle **20** is not supporting the articles W, that the obstacle sensor **31** has not detected any obstacles, or that the rear-end collision prevention sensor **32** has not detected any other transport vehicles **20**. According to the transport facility **10** as described above, it is sufficient that a worker approaches and restores only the transport vehicles **20** that need to be visually checked when restoring the transport vehicles **20**, and thus the worker's labor for restoration after occurrence of a specific event can be reduced even in the case in which the transport facility **10** includes a plurality of transport vehicles **20**.

Next, other embodiments of the transport facility **10** will be described.

(1) In the foregoing embodiment, a configuration in which the guide rail **15** is along the center in the width direction Y of the travel routes **11** and suspended from the ceiling was described as an example. However, there is no limitation to such an example, and, for example, the guide rail **15** may be on the floor. The guide rail **15** may be in contact with one of the pair of left and right travel rails **12**.

(2) In the foregoing embodiment, a configuration in which the transport vehicles **20** are unmanned overhead transport vehicles and the travel routes **11** each have a pair of left and right travel rails **12** was described as an example. However, there is no limitation to such an example, and, for example, there may be only one travel rail **12** on the floor. For example, there may be no travel rails **12**. The travel routes **11** may be on the floor suspended from the ceiling, for example. The transport vehicles **20** may be manned ground transport vehicles, for example. The transport vehicles **20** may be vehicles that are driven by an internal combustion engine, for example. The transport facility **10** may include only one transport vehicle **20**, for example.

(3) In the foregoing embodiment, a configuration in which the transport vehicles **20** travel in one direction along the travel routes **11** was described as an example. However, there is no limitation to such an example, and, for example, the transport vehicles **20** may be configured to travel in both the front and rear directions along the travel routes **11**. The obstacle sensor **31** or the rear-end collision prevention sensor **32** may be on the faces on both the forward side X**1** and the rearward side X**2** of each transport vehicle **20**.

(4) In the foregoing embodiment, a configuration in which each transport vehicle **20** includes the obstacle sensor **31** and the rear-end collision prevention sensor **32** was described as an example. However, there is no limitation to such an example, and, for example, the transport vehicle **20** does not have to include the obstacle sensor **31**. The transport vehicle **20** does not have to include the rear-end collision prevention sensor **32**.

(5) In the foregoing embodiment, a configuration in which the information holders **18** are at a plurality of points along the travel routes **11** and the transport vehicles **20** include the readers **28** was described as an example. However, there is no limitation to such an example, and, for example, there may be only one information holder **18** on the travel routes **11**. For example, there may be no information holders **18**, and a worker may input information on the travel position to the transport vehicles **20** at a predetermined position on the travel routes **11**.

(6) In the foregoing embodiment, a configuration in which each transport vehicle **20** includes the first travel section **21***a* and the second travel section **21***b* and further includes two first guided sections **25***a* and two second guided sections **25***b* was described as an example. However, there is no limitation to such an example, and, for example, the transport vehicle **20** may include one first guided section **25***a* and one second guided section **25***b*. The transport vehicle **20** may not include the second guided sections **25***b* and the second travel section **21***b*. The drive section **23** for traveling may be in one of the first travel section **21***a* and the second travel section **21***b*, and the wheels **22** in the other travel section may follow the driving.

(7) In the foregoing embodiment, a configuration in which the first guided sections **25***a* and the second guided sections **25***b* are guide wheels was described as an example. However, there is no limitation to such an example, and, for example, the first guided sections **25***a* and the second guided sections **25***b* may be configured to slide on and be guided by the guide rail **15**. The first guided sections **25***a* may be, for example, guide wheels and support sections that support the guide wheels, and the guide drive section **24** may be configured to drive the support sections together with the guide wheels in the width direction Y.

(8) In the foregoing embodiment, a configuration in which the first detecting section **27***a* can detect whether the first guided sections **25***a* are at the first position P**1** or the second position P**2** was described as an example. However, there is no limitation to such an example, and, for example, a configuration may be adopted that detects whether or not the first guided sections **25***a* have moved from the first position P**1** to the second position P**2** or from the second position P**2** to the first position P**1**, by detecting the drive or rotation of the guide drive section **24**. A configuration may be adopted that detects whether or not the first guided sections **25***a* have moved from the first position P**1** to the second position P**2** or from the second position P**2** to the first position P**1**, for example, by detecting whether or not the first guided sections **25***a* pave passed through an intermediate position between the first position P**1** and the second position P**2**.

(9) In the foregoing embodiment, a configuration in which the control system **40** sets the detection range M**1** in the width direction Y of the obstacle sensor **31** wider in response to determining that the transport vehicle is in the guide zone E**1** than in response to determining that the transport vehicle is in the non-guide zone E**2** was described as an example. However, there is no limitation to such an example, and, for example, a configuration may be adopted that sets the detection range M**1** longer in the up-down direction Z or the travel direction X of the obstacle sensor **31**.

Hereinafter, the transport facility in the foregoing description will be described.

The present disclosure is directed to a transport facility including: a transport vehicle configured to travel along a travel route; a guide rail along the travel route; and a control system configured to control the transport vehicle, wherein, with a travel direction being a direction along the travel route, a width direction being a direction orthogonal to the travel direction in a vertical view, a first side in the width direction being one side in the width direction, and a second side in the width direction being another side in the width direction, the transport vehicle includes: a guided section configured to be guided by the guide rail; and a guide drive section configured to drive the guided section in the width direction to move the guided section to a first position on the first side in the width direction of the guide rail and to a second position on the second side in the width direction of the guide rail, the travel route includes a guide zone in which the guide rail is disposed and a non-guide zone in which the guide rail is not disposed, and, in response to occurrence of a specific event in which the transport vehicle loses information on a travel position thereof, the control system (i) causes the guide drive section to execute a confirmation operation to drive the guided section in the width direction, (ii) determines that the transport vehicle is in the non-guide zone in response to the guided section moving from the first position to the second position or from the second position to the first position in the confirmation operation, and (iii) determines that the transport vehicle is in the guide zone in response to the guided section being prevented from moving from the first position to the second position or from the second position to the first position in the confirmation operation.

This configuration makes it possible to determine whether a transport vehicle is in the guide zone or the non-guide zone, through a confirmation operation to drive the guided section in the width direction, even if a specific event in which the transport vehicle loses information on its travel position occurs. Accordingly, the control system can cause the transport vehicle to perform proper control according to whether the transport vehicle is in the guide zone or the non-guide zone. Therefore, the control system can properly resume control of the transport vehicle, even if a specific event in which the transport vehicle loses information on its travel position occurs.

According to an aspect, it is preferable that the transport vehicle further includes an obstacle sensor configured to detect an obstacle on a forward side in the travel direction, the guide rail is in at least either a zone in which the travel route intersects another travel route or a zone in which the travel route is curved, and the control system sets a detection range of the obstacle sensor wider in response to determining that the transport vehicle is in the guide zone than in response to determining that the transport vehicle is in the non-guide zone as a result of the confirmation operation.

This configuration makes it possible to properly set a detection range of the obstacle sensor according to whether the transport vehicle is in the guide zone or the non-guide zone. Therefore, it is possible to increase the possibility of proper detection of obstacles such as other transport vehicles in branch or merge parts of the guide zone, while reducing the possibility of false detection in which objects that are not obstacles are detected as obstacles in the non-guide zone. Accordingly, the control system can cause the transport vehicle to properly travel upon resuming the control of the transport vehicle.

According to an aspect, it is preferable that the transport facility further includes an information holder holding positional information on a position thereof, at each of a plurality of points along the travel route, wherein the transport vehicle further includes a reader configured to read the positional information of the plurality of information holders and recognize a travel position of the transport vehicle based on the information read by the reader, the control system executes restoration processing to allow the transport vehicle to start traveling after the specific event is resolved, and the transport vehicle in the restoration processing is caused to travel at or below a predetermined first speed limit for restoration from when the stopped transport vehicle starts traveling to when the transport vehicle reads the positional information of an information holder among the plurality of information holders.

This configuration makes it possible to cause the transport vehicle to travel at low speed that is at or below the first speed limit for restoration, while causing the transport vehicle to perform control according to whether the transport vehicle is in the guide zone or the non-guide zone based on the confirmation operation even if a specific event occurs and the transport vehicle loses information on its travel position. Accordingly, it is possible to automatically execute a series of processing from completing the restoration processing by causing the transport vehicle to travel and recognize its travel position to returning to normal processing, while reducing the possibility of issues such as the transport vehicle colliding with another transport vehicle.

According to an aspect, it is preferable that, in the restoration processing, the control system (i) causes the transport vehicle to travel at or below the first speed limit for restoration in response to determining that the transport vehicle is in the non-guide zone as a result of the confirmation operation, and (ii) causes the transport vehicle to travel at or below a second speed limit for restoration, which is lower than the first speed limit for restoration, in response to determining that the transport vehicle is in the guide zone as a result of the confirmation operation.

This configuration makes it possible to further reduce the possibility of issues such as the transport vehicle colliding with another transport vehicle.

According to an aspect, it is preferable that in response to occurrence of the specific event on a plurality of transport vehicles on the travel route, the control system causes the plurality of transport vehicles to simultaneously execute the confirmation operation.

This configuration makes it possible to reduce the worker's labor for restoration after occurrence of a specific event, even in the case in which there are a plurality of transport vehicles.

According to an aspect, it is preferable that the transport vehicle includes a first guided section that is the guided section, and a second guided section on a rearward side of the first guided section in the travel direction, the guide drive section drives the first guided section and the second guided section independently of each other in the width direction, and in response to occurrence of the specific event, the control system (i) causes the confirmation operation to be executed for both the first guided section and the second guided section, (ii) determines that the transport vehicle is in the non-guide zone in response to both the first guided section and the second guided section moving from the first position to the second position or from the second position to the first position in the confirmation operation, and (iii) determines that the transport vehicle is in the guide zone in response to at least either the first guided section or the second guided section being prevented from moving from the first position to the second position or from the second position to the first position in the confirmation operation.

This configuration makes it possible to properly execute the confirmation operation and determination based on the confirmation operation even in the case in which the transport vehicle includes a plurality of guided sections that are along the travel direction.

What is claimed is:

1. A transport facility comprising:

a transport vehicle configured to travel along a travel route;

a guide rail along the travel route; and

a control system configured to control the transport vehicle, and

wherein:

a travel direction is a direction along the travel route, a width direction is a direction orthogonal to the travel direction in a vertical view, a first side in the width direction is one side in the width direction, and a second side in the width direction is another side in the width direction,

the transport vehicle comprises:

a guided section configured to be guided by the guide rail; and

a guide drive section configured to drive the guided section in the width direction to move the guided section to a first position on the first side in the width direction of the guide rail and to a second position on the second side in the width direction of the guide rail,

the travel route comprises a guide zone in which the guide rail is disposed and a non-guide zone in which the guide rail is not disposed, and

in response to occurrence of a specific event in which the transport vehicle loses information on a travel position thereof, the control system (i) causes the guide drive section to execute a confirmation operation to drive the guided section in the width direction, (ii) determines that the transport vehicle is in the non-guide zone in response to the guided section moving from the first position to the second position or from the second position to the first position in the confirmation operation, and (iii) determines that the transport vehicle is in the guide zone in response to the guided section being prevented from moving from the first position to the second position or from the second position to the first position in the confirmation operation.

2. The transport facility according to claim **1**, wherein:

the transport vehicle further comprises an obstacle sensor configured to detect an obstacle on a forward side in the travel direction,

the guide rail is in at least either a zone in which the travel route intersects another travel route or a zone in which the travel route is curved, and

the control system sets a detection range of the obstacle sensor wider in response to determining that the transport vehicle is in the guide zone than in response to determining that the transport vehicle is in the non-guide zone as a result of the confirmation operation.

3. The transport facility according to claim **1**, further comprising:

an information holder holding positional information on a position thereof, at each of a plurality of points along the travel route, and

wherein:

the transport vehicle further comprises a reader configured to read the positional information of the plurality of information holders and recognize a travel position of the transport vehicle based on the information read by the reader,

the control system executes restoration processing to allow the transport vehicle to start traveling after the specific event is resolved, and

the transport vehicle in the restoration processing is caused to travel at or below a predetermined first speed limit for restoration from when the stopped transport vehicle starts traveling to when the transport vehicle reads the positional information of an information holder among the plurality of information holders.

4. The transport facility according to claim **3**,

wherein, in the restoration processing, the control system (i) causes the transport vehicle to travel at or below the first speed limit for restoration in response to determining that the transport vehicle is in the non-guide zone as a result of the confirmation operation, and (ii) causes the transport vehicle to travel at or below a second speed limit for restoration, which is lower than the first speed limit for restoration, in response to determining that the transport vehicle is in the guide zone as a result of the confirmation operation.

5. The transport facility according to claim **1**, wherein in response to occurrence of the specific event on a plurality of transport vehicles on the travel route, the control system causes the plurality of transport vehicles to simultaneously execute the confirmation operation.

6. The transport facility according to claim **1**, wherein:

the transport vehicle comprises a first guided section that is the guided section, and a second guided section on a rearward side of the first guided section in the travel direction,

the guide drive section drives the first guided section and the second guided section independently of each other in the width direction, and

in response to occurrence of the specific event, the control system (i) causes the confirmation operation to be executed for both the first guided section and the second guided section, (ii) determines that the transport vehicle is in the non-guide zone in response to both the first guided section and the second guided section moving from the first position to the second position or from the second position to the first position in the confirmation operation, and (iii) determines that the transport vehicle is in the guide zone in response to at least either the first guided section or the second guided section being prevented from moving from the first position to the second position or from the second position to the first position in the confirmation operation.

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