

DESCRIPTION

Title of Invention

TRAVEL SYSTEM

5 Technical Field

[0001] An aspect of the present invention relates to a traveling system.

Background Art

[0002] A traveling system is conventionally known, which includes a predetermined traveling path, a plurality of carriages capable of traveling along the traveling path, and a controller configured to control the carriages. For example, in a system described in Patent Literature 1, when a new automated transport carriage is introduced to a section where another automated transport carriage has already been permitted to travel, a system controller cancels the permission to travel for another automated transport carriage in order to prevent interference of the new automated transport carriage with another transport carriage.

Citation List

Patent Literature

[0003] Patent Literature 1: Japanese Patent No. 4019231

20 Summary of Invention

Technical Problem

[0004] In the traveling system as described above, consideration is not sufficient for control of carriages when two carriages are to pass through a merging point in the traveling path, and there is room for improvement in improving the transportation efficiency of carriages.

[0005] An aspect of the present invention is made in view of the

situation above, and a problem to be solved is to improve the transportation efficiency of carriages in a traveling system including a traveling path having a merging point.

Solution to Problem

5 [0006] A traveling system according to an aspect of the present invention includes a predetermined traveling path, a plurality of carriages capable of traveling along the traveling path, and a controller configured to control the carriages. The traveling path includes a first linear traveling path and a first curved traveling path merging through a
10 merging point on a way of the first linear traveling path. The carriage transmits a merging point passage permission request to request permission for passage through the merging point to the controller before the merging point, enters the merging point when receiving a merging point passage permission response indicating permission for
15 passage through the merging point from the controller, and waits before the merging point when not receiving the merging point passage permission response from the controller. The carriage waiting before the merging point receives the merging point passage permission response from the controller after the carriage that immediately
20 precedes the carriage waiting and has passed through the merging point passes through a predetermined point. When the merging point passage permission requests are received from a first carriage that is the carriage preceding and a second carriage that is the carriage following the first carriage and when both of types of the merging point passage
25 permission requests received from the first carriage and the second carriage are a linear type that is a type of the merging point passage

permission request at a time of moving from the first linear traveling path to the merging point, the controller transmits the merging point passage permission response to the first carriage and the second carriage. When the merging point passage permission requests are received from the first carriage and the second carriage and when the type of the merging point passage permission request received from the first carriage is a curved type that is a type of the merging point passage permission request at a time of moving from the first curved traveling path to the merging point, the controller transmits the merging point passage permission response only to the first carriage. The first carriage making the merging point passage permission request of the curved type to the controller performs at least one of: a process of changing the type of the merging point passage permission request made to the controller to the linear type; and a process of transmitting a signal to the controller to allow the controller to recognize that the type of the merging point passage permission request received from the first carriage is the linear type, after passing through the merging point from the first curved traveling path and before passing through the predetermined point.

[0007] When another carriage is present right in front of a carriage, measures against collision between these carriages are taken as general specifications. When both of the first carriage and the second carriage enter the merging point from the first linear traveling path, therefore, the merging point passage permission response is transmitted to both of the first carriage and the second carriage. Here, the first carriage entering the merging point from the first curved traveling path travels on the first

linear traveling path after passing through the merging point, which means that the first carriage is present right in front of the second carriage entering the merging point from the first linear traveling path. According to an aspect of the present invention, the first carriage passing through the merging point transmits a signal to the controller to change the type of the merging point passage permission request made to the controller to the linear type and/or to allow the controller to recognize that the type is the linear type, before passing through the predetermined point. With this configuration, the second carriage waiting before the merging point on the first linear traveling path can obtain the merging point passage permission response without waiting for the first carriage to pass through the predetermined point. As a result, the transportation efficiency of the carriages can be improved.

[0008] In the traveling system according to an aspect of the present invention, when the merging point passage permission request is received from a third carriage in addition to the first carriage and the second carriage, the third carriage being the carriage following the second carriage in addition to the first carriage and the second carriage and when all of the types of the merging point passage permission requests received from the first carriage, the second carriage, and the third carriage are the linear type, the controller may transmit the merging point passage permission response to the third carriage in addition to the first carriage and the second carriage. When the merging point passage permission request is received from the third carriage in addition to the first carriage and the second carriage and when the type of at least one of the merging point passage permission

requests received from the first carriage, the second carriage, and the third carriage is the curved type, the controller may transmit the merging point passage permission response only to the first carriage. The second carriage making the merging point passage permission request of the curved type to the controller may perform at least one of: a process of changing the type of the merging point passage permission request made to the controller to the linear type; and a process of transmitting a signal to the controller to allow the controller to recognize that the type of the merging point passage permission request received from the second carriage is the curved type, after passing through the merging point from the first curved traveling path and before passing through the predetermined point. With this configuration, when the third carriage travels from the first curved traveling path toward the merging point, the third carriage is kept waiting before the merging point, and collision between the carriages can be prevented. Furthermore, the third carriage waiting before the merging point on the first linear traveling path can obtain the passage permission response without waiting for the second carriage to pass through the predetermined point. As a result, the transportation efficiency of the carriages can be improved.

[0009] In the traveling system according to an aspect of the present invention, when the merging point passage permission requests are received from the first carriage and the second carriage and when the type of the merging point passage permission request received from the first carriage is the linear type and the type of the merging point passage permission request received from the second carriage is the curved type,

the merging point passage permission response may be transmitted only to the first carriage. In the traveling system, when the second carriage following the first carriage moves from the first curved traveling path to the merging point, the second carriage does not obtain the merging point passage permission response even when the type of the merging point passage permission request from the first carriage passing through the merging point is set to the linear type. This configuration can prevent collision between the first carriage and the second carriage. As described above, when another carriage is present right in front of a carriage, measures against collision between these carriages are taken as general specifications, but a measure is not always taken for another carriage present at a location deviating from right in front of the carriage. In the traveling system, even if this measure is not taken, collision between carriages can be prevented.

[0010] In the traveling system according to an aspect of the present invention, each of the carriages may include an intercarriage sensor configured to detect a distance from the carriage ahead. With this configuration, collision between carriages can also be avoided using the intercarriage sensor.

[0011] In the traveling system according to an aspect of the present invention, the intercarriage sensor may be a linear sensor capable of detecting the carriage right in front. With this configuration, when another carriage is present right in front of the carriage, collision between these carriages can be avoided using the linear sensor.

[0012] In the traveling system according to an aspect of the present invention, the traveling path may include a second linear traveling path

and a second curved traveling path splitting through a branching point on a way of the second linear traveling path and continuous to the first curved traveling path. The carriage may transmit a branching point passage permission request to request permission for passage through the branching point to the controller before the branching point, enter the branching point when receiving a branching point passage permission response indicating permission for passage through the branching point from the controller, and wait before the branching point when not receiving the branching point passage permission response from the controller. When the branching point passage permission requests are received from a fourth carriage that is the carriage preceding and a fifth carriage that is the carriage following the fourth carriage and when the type of the branching point passage permission request received from the fourth carriage is a curved type that is a type of the branching point passage permission request at a time of moving from the branching point to the second curved traveling path and the type of the branching point passage permission request received from the fifth carriage is a linear type that is a type of the branching point passage permission request at a time of moving from the branching point to the second linear traveling path, the controller may transmit the branching point passage permission response only to the fourth carriage. When the fourth carriage reaches a location where the fifth carriage does not interfere even when passing through the branching point, the controller may transmit the branching point passage permission response to the fifth carriage. With this configuration, when the fourth carriage enters the second curved traveling path from the branching

point and the fifth carriage moves from the branching point to the second linear traveling path, the fifth carriage can pass through the branching point at an earlier timing.

Advantageous Effects of Invention

5 [0013] According to an aspect of the present invention, the transportation efficiency of carriages can be improved in a traveling system including a traveling path having a merging point.

Brief Description of Drawings

10 [0014] FIG. 1 is a schematic plan view illustrating a traveling system according to an embodiment.

FIG. 2 is a block diagram illustrating a functional configuration of a carriage in FIG. 1.

FIG. 3 is a schematic front view of the carriage in FIG. 1 as viewed from a traveling direction.

15 FIG. 4 is a schematic plan view illustrating a process of an area controller in FIG. 1.

FIG. 5 is a schematic plan view illustrating a process of the area controller in FIG. 1.

20 FIG. 6(a) is a schematic plan view illustrating a process of the area controller in FIG. 1. FIG. 6(b) is a schematic plan view continued from FIG. 6(a). FIG. 6(c) is a schematic plan view continued from FIG. 6(b).

25 FIG. 7(a) is a schematic plan view illustrating a process of the area controller in FIG. 1. FIG. 7(b) is a schematic plan view continued from FIG. 7(a). FIG. 7(c) is a schematic plan view continued from FIG. 7(b).

FIG. 8 is a schematic plan view illustrating a process of the area controller in FIG. 1.

FIG. 9(a) is a schematic plan view illustrating a process of the area controller in FIG. 1. FIG. 9(b) is a schematic plan view continued from FIG. 9(a). FIG. 9(c) is a schematic plan view continued from FIG. 9(b).

FIG. 10 is a schematic plan view illustrating a process of the area controller in FIG. 1.

FIG. 11(a) is a schematic plan view illustrating a process of the area controller in FIG. 1. FIG. 11(b) is a schematic plan view continued from FIG. 11(a). FIG. 11(c) is a schematic plan view continued from FIG. 11(b).

FIG. 12 is a schematic plan view illustrating a process of the area controller in FIG. 1.

FIG. 13(a) is a schematic plan view illustrating a process of the area controller in FIG. 1. FIG. 13(b) is a schematic plan view continued from FIG. 13(a). FIG. 13(c) is a schematic plan view continued from FIG. 13(b).

FIG. 14 is a schematic plan view illustrating a process of the area controller in FIG. 1.

FIG. 15(a) is a schematic plan view illustrating a process of the area controller in FIG. 1. FIG. 15(b) is a schematic plan view continued from FIG. 15(a). FIG. 15(c) is a schematic plan view continued from FIG. 15(b).

FIG. 16 is a schematic plan view illustrating a process of the area controller in FIG. 1.

FIG. 17 is a schematic plan view continued from FIG. 16.

FIG. 18(a) is a schematic plan view illustrating a process of the area controller in FIG. 1. FIG. 18(b) is a schematic plan view continued from FIG. 18(a). FIG. 18(c) is a schematic plan view continued from FIG. 18(b).

FIG. 19(a) is a schematic plan view continued from FIG. 18(b). FIG. 19(b) is a schematic plan view continued from FIG. 19(a).

FIG. 20 is a schematic plan view illustrating a process of the area controller in FIG. 1.

FIG. 21 is a schematic plan view illustrating a process of the area controller in FIG. 1.

FIG. 22(a) is a schematic plan view illustrating a process of the area controller in FIG. 1. FIG. 22(b) is a schematic plan view continued from FIG. 22(a). FIG. 22(c) is a schematic plan view continued from FIG. 22(b).

Description of Embodiments

[0015] An embodiment will be described in detail below with reference to the drawings. In the description of the drawings, the same or corresponding elements are denoted by the same reference signs and an overlapping description is omitted.

[0016] As illustrated in FIG. 1, FIG. 2, and FIG. 3, a traveling system 1 forms a system that transports an article 10. The article 10 is, for example, a container storing a plurality of semiconductor wafers or may be glass substrates or general parts. The traveling system 1 includes a track 4, carriages 6, and an area controller (controller) 60.

[0017] The track 4 is a predetermined traveling path to allow the

carriages 6 to travel. The track 4 is laid, for example, in the vicinity of the ceiling that is a space above the worker's head. The track 4 is suspended from the ceiling. The track 4 is supported by struts 48. The track 4 includes a plurality of routes 40, a merging point G where a plurality of routes 40 merge, and a branching point B where one route 40 is split into a plurality of routes 40. The layout of the track 4 (the configuration of the routes 40 and the numbers of merging points G and branching points B) is not limited, and a variety of layouts can be employed.

[0018] The routes 40 include a linear route (first linear traveling path) 41 extending linearly, a linear route (second linear traveling path) 42 extending linearly in parallel with the linear route 41, and a curve route (first curved traveling path, second curved traveling path) 43 merging through the merging point G on the way of the linear route 41 and splitting through the branching point B on the way of the linear route 42.

[0019] A stop point T (see FIG. 4) that is a location where the carriage 6 stops is provided before (the upstream side of) the merging point G or the branching point B on the track 4. The stop point T is a predetermined location. The stop point T can be set with reference to a plurality of point marks P such as barcodes affixed so as to be aligned at regular intervals along the track 4. The stop point T is set for each of a plurality of merging points G and branching points B. In the drawings, for convenience of explanation, the point marks P and the stop point T are depicted by circles on the track 4.

[0020] The carriage 6 can travel along the track 4. The carriage 6

transports the article 10. The carriage 6 is configured to transfer the article 10 to a not-illustrated port. The carriage 6 is an Overhead Hoist Transport. The carriage 6 is also called, for example, traveling carriage, transport carriage, overhead traveling vehicle (overhead traveling carriage), or transport vehicle (transport carriage). The number of carriages 6 included in the traveling system 1 is not limited and is more than one.

[0021] The carriage 6 includes a traveling unit 18 and a power-receiving communication unit 20. The traveling unit 18 allows the carriage 6 to travel along the track 4. The power-receiving communication unit 20 receives power from the track 4 side, for example, via wireless charging. The carriage 6 includes a θ drive 26, a traverse unit 24 for allowing the portion therebelow to traverse relative to the track 4, an elevation drive unit 28, and an elevation stage 30. The θ drive 26 turns the elevation drive unit 28 in a horizontal plane to control the posture of the article 10. The elevation drive unit 28 elevates and lowers the elevation stage 30 gripping the article 10. The elevation stage 30 has a chuck and can grip or release the article 10. The traverse unit 24 and the θ drive 26 are not necessarily provided.

[0022] The carriage 6 has a linear sensor 8. The linear sensor 8 is an intercarriage sensor detecting the distance from a carriage 6 ahead. The linear sensor 8 is a sensor capable of detecting a carriage 6 right in front. The linear sensor 8 detects a carriage 6 ahead by emitting laser light toward the front of the carriage 6 concerned (the carriage 6 including the linear sensor 8) and detecting reflection light reflected by a reflector on the carriage 6 ahead. For example, the linear sensor 8 is

arranged on a drop-preventing cover 33 on the front side of the carriage 6. The linear sensor 8 transmits the detection result to a carriage controller 50 described later. The carriage 6 does not include a curve sensor that is a sensor capable of detecting a carriage 6 ahead traveling on a curve route.

[0023] The carriage 6 includes a position acquisition unit (not illustrated) to acquire position information about the position of the carriage 6 on the track 4. The position acquisition unit is configured with, for example, a reader and an encoder for reading a point mark P on the track 4. The position information of the carriage 6 includes, for example, information on a point mark P obtained by the reader and information on the traveling direction after the point mark P is passed through.

[0024] The carriage 6 includes a carriage controller 50. The carriage controller 50 is an electronic control unit including a central processing unit (CPU), a read only memory (ROM), and a random access memory (RAM). The carriage controller 50 can be configured, for example, as software with a computer program stored in the ROM, loaded onto the RAM, and executed by the CPU. The carriage controller 50 may be configured as hardware with electronic circuitry, for example. The carriage controller 50 may be configured with one device or may be configured with a plurality of devices. When the carriage controller 50 is configured with a plurality of devices, they are connected to each other to construct a logically one carriage controller 50.

[0025] The carriage controller 50 controls a variety of operations of the carriage 6. The carriage controller 50 controls the traveling unit 18,

the traverse unit 24, the θ drive 26, the elevation drive unit 28, and the elevation stage 30. The carriage controller 50 communicates with the area controller 60, for example, using a power feeder of the track 4. Alternatively, the carriage controller 50 may communicate with the area controller 60 through a communication line (feeder line) provided along the track 4, separately from the power feeder.

[0026] When receiving a status inquiry from the area controller 60, the carriage controller 50 transmits a status report from the carriage 6 concerned (the carriage 6 including the carriage controller 50) to the area controller 60. The status report includes position information of the carriage 6 concerned. The carriage controller 50 determines whether the distance between the carriage 6 concerned and another carriage 6 ahead is a prescribed distance or shorter, based on the detection result of the linear sensor 8. When the distance between the carriages is equal to or shorter than a prescribed distance, the carriage controller 50 decelerates or stops the carriage 6 concerned.

[0027] The carriage controller 50 transmits a status report including a merging point passage permission request to the area controller 60 before a merging point G when the carriage 6 concerned attempts to pass through the merging point G. The merging point passage request is a signal requesting permission for passage through the merging point G. When receiving a merging point passage permission response from the area controller 60, the carriage controller 50 allows the carriage 6 concerned to enter the merging point G. The merging point passage permission response is a signal indicating permission for passage through the merging point G. When not receiving a merging point

passage permission response from the area controller 60, the carriage controller 50 stops the carriage 6 concerned and keeps it waiting at the stop point T before the merging point G.

[0028] The carriage controller 50 transmits a status report including a branching point passage permission request to the area controller 60 before a branching point B when the carriage 6 concerned attempts to pass through the branching point B. The branching point passage request is a signal requesting permission for passage through the branching point B. When receiving a branching point passage permission response from the area controller 60, the carriage controller 50 allows the carriage 6 concerned to enter the branching point B. The branching point passage permission response is a signal indicating permission for passage through the branching point B. When not receiving a branching point passage permission response from the area controller 60, the carriage controller 50 stops the carriage 6 concerned and keeps it waiting at the stop point T before the branching point B.

[0029] The carriage controller 50 of the carriage 6 waiting at the stop point T before the merging point G receives a merging point passage permission response from the area controller 60 after the carriage 6 that immediately precedes the carriage 6 waiting and has passed through the merging point G passes through a post-merging point (predetermined point) that is a point (a point on the track 4) downstream from the merging point G. The carriage controller 50 of the carriage 6 waiting at the stop point T before the branching point B receives a branching point passage permission response from the area controller 60 after the carriage 6 that immediately precedes the carriage 6 waiting and has

passed through the branching point B passes through one of first to third post-branching points that are points downstream from the branching point B.

[0030] The area controller 60 is an electronic control unit including a CPU, a ROM, and a RAM. The area controller 60 can be configured, for example, as software with a computer program stored in the ROM, loaded onto the RAM, and executed by the CPU. The area controller 60 may be configured as hardware with electronic circuitry, for example. The area controller 60 may be configured with one device or may be configured with a plurality of devices. When the area controller 60 is configured with a plurality of devices, they are connected via a communication network such as the Internet or an intranet to construct a logically one area controller 60.

[0031] The area controller 60 communicates with a plurality of carriages 6 in its control area and controls a plurality of carriages 6 in its control area. The area controller 60 communicates with a higher-level controller (not illustrated) by wire or wirelessly.

[0032] The area controller 60 periodically communicates with a plurality of carriages 6 in its control area. For example, the area controller 60 transmits a status inquiry to a carriage 6 in its control area, and the carriage 6 receiving the status inquiry transmits a status report to the area controller 60. The area controller 60 grasps the status of a plurality of carriages 6 in the control area by successively and periodically performing such communication with a plurality of carriages 6 in the control area.

[0033] The area controller 60 performs next blocking control when a

carriage 6 passes through a merging point G. Specifically, when a merging point passage request pertaining to a merging point G is received from a carriage 6, if a lock area RG (see FIG. 13(b)) to prohibit entry into the area including the merging point G is not set, the area controller 60 transmits a merging point passage permission response to the carriage 6 and permits passage of the carriage 6 through the merging point G, and sets a lock area RG. The lock area RG is released after the carriage 6 passing through the merging point G passes through a post-merging point that is a point downstream from the merging point G on the track 4. When a merging point passage request pertaining to a merging point G is received from a carriage 6, if a lock area RG is set and series travel of a plurality of carriages 6 described later is not established, the area controller 60 does not transmit a merging point passage permission response to the carriage 6 and keeps the carriage 6 waiting at the stop point T.

[0034] The area controller 60 performs next blocking control when a carriage 6 passes through a branching point B. Specifically, when a branching point passage request pertaining to a branching point B is received from a carriage 6, if a lock area RB (see FIG. 6(b)) to prohibit entry into the area including the branching point B is not set, the area controller 60 transmits a branching point passage permission response to the carriage 6 and permits passage of the carriage 6 through the branching point B, and sets the lock area RB. The lock area RB is released after the carriage 6 passing through the branching point B passes through one of first to third post-branching points that are points downstream from the branching point B on the track 4. When a

branching point passage request pertaining to a branching point B is received from a carriage 6, if a lock area RB is set and series travel of a plurality of carriages 6 described later is not established, the area controller 60 does not transmit a branching point passage permission response to the carriage 6 and keeps the carriage 6 waiting at the stop point T.

[0035] The process of the area controller 60 in the present embodiment will now be described in detail below.

[0036] Hereinafter a carriage 6 that precedes is referred to as preceding carriage 6A. A carriage 6 that follows the preceding carriage 6A (carriage 6 predicted to pass through a merging point G or a branching point B after the preceding carriage 6A) is referred to as following carriage 6B. The types of the merging point passage permission request and the branching point passage request include the types of requests. The type of the merging point passage permission request includes a "linear type" that is a type at a time of moving from the linear route 41 to the merging point G and a "curved type" that is a type at a time of moving from the curve route 43 to the merging point G. The type of the branching point passage permission request includes a "linear type" that is a type at a time of moving from the branching point B to the linear route 42 and a "curved type" that is a type at a time of moving from the branching point B to the curve route 43.

[0037] As illustrated in FIG. 4, when branching point passage permission requests S1 are received from the preceding carriage 6A and the following carriage 6B and when both of the types of the branching point passage permission requests S1 received from the preceding

carriage 6A and the following carriage 6B are the linear type (at a time of series travel of a plurality of carriages 6), the area controller 60 transmits a branching point passage permission response S2 to each of the preceding carriage 6A and the following carriage 6B. As a result, both of the preceding carriage 6A and the following carriage 6B pass through the lock area RB including the branching point B without stopping and travel on the linear route 42.

[0038] As illustrated in FIG. 5, when branching point passage permission requests S1 are received from the preceding carriage 6A and the following carriage 6B and when the type of the branching point passage permission request S1 received from the preceding carriage 6A is the curved type and the type of the branching point passage permission request S1 received from the following carriage 6B is the linear type or the curved type, the area controller 60 transmits a branching point passage permission response S2 only to the preceding carriage 6A. As a result, the preceding carriage 6A passes through the lock area RB including the branching point B without stopping and travels on the linear route 42. The following carriage 6B stops and waits at the stop point T before the branching point B.

[0039] For example, as illustrated in FIG. 6(a), the area controller 60 receives branching point passage permission requests S1 from both of the preceding carriage 6A and the following carriage 6B approaching the branching point B. The type of the branching point passage permission request S1 from the preceding carriage 6A is the curved type, and the type of the branching point passage permission request S1 from the following carriage 6B is the curved type. The area controller

60 does not set the lock area RB and transmits a branching point passage permission response S2 to the preceding carriage 6A. Thus, as illustrated in FIG. 6(b), the preceding carriage 6A passes through the branching point B. In addition, the area controller 60 sets the area of the branching point B as the lock area RB. The area controller 60 does not transmit a branching point passage permission response S2 to the following carriage 6B, and the following carriage 6B stops before the branching point B.

[0040] As illustrated in FIG. 6(c), after the preceding carriage 6A moves from the branching point B to the curve route 43, moves to the linear route 41, and passes through the first post-branching point P1, the area controller 60 clears the setting of the lock area RB. Thus, the area controller 60 transmits a branching point passage permission response S2 to the following carriage 6B to enable the following carriage 6B to pass through the branching point B. In the example illustrated in the drawing, the first post-branching point P1 is a location at the point mark P immediately after the merging point G. The first post-branching point P1 is not limited. The first post-branching point P1 may be various locations at a sufficient distance from the branching point B.

[0041] For example, as illustrated in FIG. 7(a), the area controller 60 receives branching point passage permission requests S1 from both of the preceding carriage 6A and the following carriage 6B approaching the branching point B. The type of the branching point passage permission request S1 from the preceding carriage 6A is the curved type, and the type of the branching point passage permission request S1 from the following carriage 6B is the linear type. The area controller

60 does not set the lock area RB and transmits a branching point passage permission response S2 to the preceding carriage 6A. Thus, as illustrated in FIG. 7(b), the preceding carriage 6A passes through the branching point B. In addition, the area controller 60 sets the area of the branching point B as the lock area RB. The area controller 60 does not transmit a branching point passage permission response S2 to the following carriage 6B, and the following carriage 6B stops before the branching point B.

[0042] As illustrated in FIG. 7(c), after the preceding carriage 6A moves from the branching point B to the curve route 43 and passes through the second post-branching point P2, the area controller 60 clears the setting of the lock area RB. Thus, the area controller 60 transmits a branching point passage permission response S2 to the following carriage 6B to enable the following carriage 6B to pass through the branching point B.

In the example illustrated in the drawing, the second post-branching point P2 is a location where the preceding carriage 6A does not interfere with the following carriage 6B even when passing through the branching point B, for example, at a location on the downstream side on the curve route 43. The second post-branching point P2 is not limited.

The second post-branching point P2 may be various locations where the preceding carriage 6A does not interfere with the following carriage 6B even when passing through the branching point B. The second post-branching point P2 may be any location upstream from the first post-branching point P1.

[0043] As illustrated in FIG. 8, when branching point passage permission requests S1 are received from the preceding carriage 6A and

the following carriage 6B and when the type of the branching point passage permission request S1 received from the preceding carriage 6A is the linear type and the type of the branching point passage permission request S1 received from the following carriage 6B is the curved type,
5 the area controller 60 transmits a branching point passage permission response S2 only to the preceding carriage 6A. As a result, the preceding carriage 6A passes through the lock area RB including the branching point B without stopping and travels on the linear route 42. The following carriage 6B stops and waits at the stop point T before the
10 branching point B.

[0044] For example, as illustrated in FIG. 9(a), the area controller 60 receives branching point passage permission requests S1 from both of the preceding carriage 6A and the following carriage 6B approaching the branching point B. The type of the branching point passage permission request S1 from the preceding carriage 6A is the linear type,
15 and the type of the branching point passage permission request S1 from the following carriage 6B is the curved type. The area controller 60 does not set the lock area RB and transmits a branching point passage permission response S2 to the preceding carriage 6A. Thus, as illustrated in FIG. 9(b), the preceding carriage 6A passes through the branching point B. In addition, the area controller 60 sets the area of the branching point B as the lock area RB. The area controller 60 does not transmit a branching point passage permission response S2 to the
20 following carriage 6B, and the following carriage 6B stops before the branching point B.
25

[0045] As illustrated in FIG. 9(c), after the preceding carriage 6A moves

from the branching point B to the linear route 42 and passes through the third post-branching point P3, the area controller 60 clears the setting of the lock area RB. Thus, the area controller 60 transmits a branching point passage permission response S2 to the following carriage 6B to enable the following carriage 6B to pass through the branching point B. In the example illustrated in the drawing, the third post-branching point P3 is a location at the point mark P immediately after the branching point B. The third post-branching point P3 is not limited. The third post-branching point P3 may be various locations at a sufficient distance from the branching point B.

[0046] As illustrated in FIG. 10, when merging point passage permission requests S3 are received from the preceding carriage 6A and the following carriage 6B and when both of the types of the merging point passage permission requests S3 received from the preceding carriage 6A and the following carriage 6B are the linear type (at a time of series travel of a plurality of carriages 6), the area controller 60 transmits a merging point passage permission response S4 to each of the preceding carriage 6A and the following carriage 6B. As a result, both of the preceding carriage 6A and the following carriage 6B pass through the lock area RG including the merging point G without stopping and travel on the linear route 41.

[0047] For example, as illustrated in FIG. 11(a), the area controller 60 receives merging point passage permission requests S3 from both of the preceding carriage 6A and the following carriage 6B approaching the merging point G. The type of the merging point passage permission request S3 from the preceding carriage 6A is the linear type, and the

type of the merging point passage permission request S3 from the following carriage 6B is the linear type. Thus, the area controller 60 transmits a merging point passage permission response S4 to the preceding carriage 6A and sets the area of the merging point G as the lock area RG. The area controller 60 also transmits a merging point passage permission response S4 to the following carriage 6B. Thus, as illustrated in FIG. 11(b), the preceding carriage 6A and the following carriage 6B pass through the lock area RG including the merging point G without stopping.

[0048] As illustrated in FIG. 11(c), after the following carriage 6B moves from the merging point G to the linear route 41 and passes through the post-merging point P4, the area controller 60 clears the setting of the lock area RG. This enables other carriages 6 to pass through the merging point G. In the example illustrated in the drawing, the post-merging point P4 is defined as a location such that a plurality of point marks P are present between the post-merging point P4 and the merging point G. The post-merging point P4 is not limited. The post-merging point P4 may be various locations at a sufficient distance from the merging point G. The post-merging point P4 is a point where the carriage 6 entering the linear route 41 from the curve route 43 through the merging point G can be oriented in a direction along the linear route 41 perfectly and with a margin, even with careful consideration of various factors (variations in posture of the carriage 6 at the same location).

[0049] As illustrated in FIG. 12, when merging point passage permission requests S3 are received from the preceding carriage 6A and

the following carriage 6B and when the type of the merging point passage permission request S3 received from the preceding carriage 6A is the linear type and the type of the merging point passage permission request S3 received from the following carriage 6B is the curved type,
5 the area controller 60 transmits a merging point passage permission response S4 only to the preceding carriage 6A. As a result, the preceding carriage 6A passes through the lock area RG including the merging point G without stopping and travels on the linear route 41. The following carriage 6B stops and waits at the stop point T before the
10 merging point G and before the branching point B.

[0050] For example, as illustrated in FIG. 13(a), the area controller 60 receives merging point passage permission requests S3 from both of the preceding carriage 6A and the following carriage 6B approaching the merging point G. The type of the merging point passage permission
15 request S3 from the preceding carriage 6A is the linear type, and the type of the merging point passage permission request S3 from the following carriage 6B is the curved type. Thus, the area controller 60 transmits a merging point passage permission response S4 only to the preceding carriage 6A. Thus, as illustrated in FIG. 13(b), the
20 preceding carriage 6A passes through the merging point G. In addition, the area controller 60 sets the area of the merging point G as the lock area RG. The area controller 60 does not transmit a merging point passage permission response S4 to the following carriage 6B, and the following carriage 6B stops before the merging point G and before the
25 branching point B. As illustrated in FIG. 13(c), after the preceding carriage 6A moves from the merging point G to the linear route 41 and

passes through the post-merging point P4, the area controller 60 clears the setting of the lock area RG. Thus, the area controller 60 transmits a merging point passage permission response S4 to the following carriage 6B to enable the following carriage 6B to pass through the merging point G.

[0051] As illustrated in FIG. 14, when merging point passage permission requests S3 are received from the preceding carriage 6A and the following carriage 6B and when the type of the merging point passage permission request S3 received from the preceding carriage 6A is the curved type and the type of the merging point passage permission request S3 received from the following carriage 6B is the curved type, the area controller 60 transmits a merging point passage permission response S4 only to the preceding carriage 6A. As a result, the preceding carriage 6A passes through the lock area RG including the merging point G without stopping and travels on the linear route 41. The following carriage 6B stops and waits at the stop point T before the merging point G and before the branching point B.

[0052] For example, as illustrated in FIG. 15(a), the area controller 60 receives merging point passage permission requests S3 from both of the preceding carriage 6A and the following carriage 6B approaching the merging point G. The type of the merging point passage permission request S3 from the preceding carriage 6A is the curved type, and the type of the merging point passage permission request S3 from the following carriage 6B is the curved type. Thus, the area controller 60 transmits a merging point passage permission response S4 only to the preceding carriage 6A. Thus, as illustrated in FIG. 15(b), the

preceding carriage 6A passes through the merging point G. In addition, the area controller 60 sets the area of the merging point G as the lock area RG. The area controller 60 does not transmit a merging point passage permission response S4 to the following carriage 6B, and the following carriage 6B stops before the merging point G and before the branching point B. As illustrated in FIG. 15(c), after the preceding carriage 6A moves from the merging point G to the linear route 41 and passes through the post-merging point P4, the area controller 60 clears the setting of the lock area RG. Thus, the area controller 60 transmits a merging point passage permission response S4 to the following carriage 6B to enable the following carriage 6B to pass through the merging point G.

[0053] As illustrated in FIG. 16, when merging point passage permission requests S3 are received from the preceding carriage 6A and the following carriage 6B and when the type of the merging point passage permission request S3 received from the preceding carriage 6A is the curved type and the type of the merging point passage permission request S3 received from the following carriage 6B is the linear type, the area controller 60 transmits a merging point passage permission response S4 only to the preceding carriage 6A. As a result, the preceding carriage 6A passes through the lock area RG including the merging point G without stopping and travels on the linear route 41. The following carriage 6B stops and waits at the stop point T before the merging point G.

[0054] Here, as illustrated in FIG. 17, after passing through the merging point G from the curve route 43 and before passing through the

post-merging point P4, the preceding carriage 6A performs a process of changing the type of the merging point passage permission request made to the area controller 60 (that is, the type of the merging point passage permission request included in the status report transmitted from the carriage controller 50 (see FIG. 2) to the area controller 60) to the linear type.

[0055] The point after passing through the merging point G and before passing through the post-merging point P4 is not limited. The point after passing through the merging point G and before passing through the post-merging point P4 is, for example, a location at the point mark P immediately after the merging point G on the linear route 41. The point after passing through the merging point G and before passing through the post-merging point P4 may be any location between the merging point G and the post-merging point P4 on the linear route 41.

[0056] Thus, the area controller 60 promptly transmits a merging point passage permission response S4 not only to the preceding carriage 6A but also to the following carriage 6B because the types of the merging point passage permission requests S3 received from the preceding carriage 6A and the following carriage 6B are set to the linear type. As a result, the preceding carriage 6A passes through the lock area RG including the merging point G and, in addition, the following carriage 6B waiting also passes through the lock area RG and travels on the

linear route 41.

[0057] For example, as illustrated in FIG. 18(a), the area controller 60 receives merging point passage permission requests S3 from both of the preceding carriage 6A and the following carriage 6B approaching the merging point G. The type of the merging point passage permission request S3 from the preceding carriage 6A is the curved type, and the type of the merging point passage permission request S3 from the following carriage 6B is the linear type. Thus, the area controller 60 transmits a merging point passage permission response S4 only to the preceding carriage 6A. Thus, as illustrated in FIG. 18(b), the preceding carriage 6A passes through the merging point G. In addition, the area controller 60 sets the area of the merging point G as the lock area RG. The area controller 60 does not transmit a merging point passage permission response S4 to the following carriage 6B, and the following carriage 6B stops before the merging point G.

[0058] As illustrated in FIG. 18(c), at the timing after the preceding carriage 6A enters the linear route 41 from the merging point G and before it reaches the post-merging point P4 (here, the timing when it passes through the first point mark P), the area controller 60 receives a merging point passage permission request S3 of the linear type from the preceding carriage 6A. Thus, both of the types of the merging point passage permission requests S3 from the preceding carriage 6A and the following carriage 6B are the linear type, and the area controller 60 transmits a merging point passage permission response S4 to the following carriage 6B in addition to the preceding carriage 6A. As illustrated in FIG. 19(a), the following carriage 6B that has stopped

starts traveling, passes through the lock area RG including the merging point G, and travels on the linear route 41. Then, as illustrated in FIG. 19(b), after the following carriage 6B passes through the post-merging point P4, the area controller 60 clears the setting of the lock area RG. This enables other carriages 6 to pass through the merging point G.

[0059] In the traveling system 1, when another carriage 6 is present right in front of a carriage 6, measures against collision (crash) between these carriages are taken as general specifications (various known arts).

When both of the preceding carriage 6A and the following carriage 6B enter the merging point G from the linear route 41, a merging point passage permission response S4 is transmitted to both of the preceding carriage 6A and the following carriage 6B. Here, the preceding carriage 6A entering the merging point G from the curve route 43 passes through the merging point G and thereafter travels on the linear route 41, which means that the preceding carriage 6A is present right in front of the following carriage 6B entering the merging point G from the linear route 41. Then, in the traveling system 1, the preceding carriage 6A passing through the merging point G performs the process of changing the type of the merging point passage permission request S3 made to the area controller 60 to the linear type, before passing through the post-merging point P4. Thus, the following carriage 6B waiting before the merging point G on the linear route 41 can obtain a merging point passage permission response without waiting for the preceding carriage 6A to pass through the post-merging point P4. The timing when the following carriage 6B on standby starts moving can be expedited. The wait time of the following carriage 6B on standby can

be reduced. As a result, the transportation efficiency of the carriages 6 can be improved. It is noted that such a process of the traveling system 1 does not require change in layout of the track 4.

[0060] In the traveling system 1, when merging point passage permission requests S3 are received from the preceding carriage 6A and the following carriage 6B and when the type of the merging point passage permission request S3 received from the preceding carriage 6A is the linear type and the type of the merging point passage permission request S3 received from the following carriage 6B is the curved type, a merging point passage permission response S4 is transmitted only to the preceding carriage 6A. In the traveling system 1, when the following carriage 6B moves from the curve route 43 to the merging point, the following carriage 6B does not obtain a merging point passage permission response even when the type of the merging point passage permission request from the preceding carriage 6A passing through the merging point G is changed to the linear type. This can prevent collision between the preceding carriage 6A and the following carriage 6B.

[0061] In the traveling system 1, each of a plurality of carriages 6 includes the linear sensor 8 as an intercarriage sensor. With this configuration, collision between carriages 6 can also be avoided using the linear sensor 8. In particular, when another carriage 6 is present right in front of a carriage 6 concerned, collision between these carriages 6 can be avoided. When another carriage 6 is present obliquely ahead of the carriage 6 concerned, collision between these carriages 6 can be avoided through the process of the area controller 60

described above (control on the preceding carriage 6A and the following carriage 6B). The cost therefore can be reduced, for example, compared to when a curve sensor is provided.

[0062] In the traveling system 1, when branching point passage permission requests S1 are received from the preceding carriage 6A and the following carriage 6B and when the type of the branching point passage permission request S1 from the preceding carriage 6A is the curved type and the type of the branching point passage permission request S1 from the following carriage 6B is the linear type, the area controller 60 transmits a branching point passage permission response S2 only to the preceding carriage 6A. When the preceding carriage 6A reaches the second post-branching point P2 where the following carriage 6B does not interfere when the following carriage 6B passes through the branching point B, the area controller 60 transmits a branching point passage permission response S2 to the following carriage 6B. With this configuration, when the preceding carriage 6A moves from the branching point B to the curve route 43 and the following carriage 6B moves from the branching point B to the linear route 42, the following carriage 6B can pass through the branching point B at an earlier timing.

[0063] An example of a case where there is another following carriage that is a carriage 6 following the following carriage 6B (a carriage 6 predicated to pass through the merging point G next after the following carriage 6B) will be described.

[0064] As illustrated in FIG. 20, when merging point passage permission requests S3 are received from the preceding carriage 6A, the

following carriage 6B, and another following carriage 6C and when all of the types of the merging point passage permission requests S3 received from the preceding carriage 6A, the following carriage 6B, and another following carriage 6C are the linear type (at a time of series travel of a plurality of carriages 6), the area controller 60 transmits a merging point passage permission response S4 to each of these carriages. As a result, all of the preceding carriage 6A, the following carriage 6B, and another following carriage 6C pass through the lock area RG including the merging point G without stopping and travel on the linear route 41.

[0065] As illustrated in FIG. 21, when merging point passage permission requests S3 are received from the preceding carriage 6A, the following carriage 6B, and another following carriage 6C and when the types of the merging point passage permission requests S3 received from the preceding carriage 6A and the following carriage 6B are the linear type and the type of the merging point passage permission request S3 received from another following carriage 6C is the curved type, the area controller 60 transmits a merging point passage permission response S4 only to the preceding carriage 6A and the following carriage 6B. As a result, the preceding carriage 6A and the following carriage 6B pass through the lock area RG including the merging point G without stopping and travel on the linear route 41. Another following carriage 6C stops and waits at the stop point T before the merging point G and before the branching point B.

[0066] For example, the area controller 60 receives merging point passage permission requests S3 from the preceding carriage 6A, the

following carriage 6B, and another following carriage 6C approaching the merging point G. The types of the merging point passage permission requests S3 from the preceding carriage 6A and the following carriage 6B are the linear type, and the type of the merging point passage permission request S3 from another following carriage 6C is the curved type. Thus, the area controller 60 transmits a merging point passage permission response S4 only to the preceding carriage 6A and the following carriage 6B. Thus, as illustrated in FIG. 22(a) and FIG. 22(b), the preceding carriage 6A and the following carriage 6B pass through the merging point G. In addition, the area controller 60 sets the area of the merging point G as the lock area RG. The area controller 60 does not transmit a merging point passage permission response S4 to another following carriage 6C, and another following carriage 6C stops before the merging point G and before the branching point B. As illustrated in FIG. 22(c), after the following carriage 6B moves from the merging point G to the linear route 41 and passes through the post-merging point P4, the area controller 60 clears the setting of the lock area RG. Thus, the area controller 60 transmits a merging point passage permission response S4 to another following carriage 6C to enable another following carriage 6C to pass through the merging point G.

[0067] When merging point passage permission requests S3 are received from the preceding carriage 6A, the following carriage 6B, and another following carriage 6C and when the type of the merging point passage permission request S3 received from the following carriage 6B is the curved type and the types of the merging point passage permission

requests S3 received from the preceding carriage 6A and another following carriage 6C are the linear type, the area controller 60 transmits a merging point passage permission response S4 only to the preceding carriage 6A. Subsequently, after the preceding carriage 6A passes through the post-merging point P4, the area controller 60 transmits a merging point passage permission response S4 only to the following carriage 6B. As a result, another following carriage 6C stops and waits at the stop point T at the merging point G. The following carriage 6B performs the process of changing the type of the merging point passage permission request S3 made to the area controller 60 to the linear type, after passing through the merging point G from the curve route 43 and before passing through the post-merging point P4. Thus, the area controller 60 transmits a merging point passage permission response S4 not only to the following carriage 6B but also to another following carriage 6C because both of the types of the merging point passage permission requests S3 received from the following carriage 6B and another following carriage 6C are set to the linear type. As a result, the preceding carriage 6A and the following carriage 6B pass through the lock area RG including the merging point G and, in addition, another following carriage 6C waiting also passes through the lock area RG and travels on the linear route 41.

[0068] In this way, in the traveling system 1, when a merging point passage permission request S3 is further received from another following carriage 6C and when all of the types of the merging point passage permission requests S3 from the carriages 6A to 6C are the linear type, the area controller 60 transmits a merging point passage

permission response to the carriages 6A to 6C. When the type of at least one of the merging point passage permission requests S3 from the carriages 6A to 6C is the curved type, the area controller 60 transmits a merging point passage permission response only to the preceding carriage 6A. The following carriage 6B making a merging point passage permission request S3 of the curved type performs the process of changing the type of the merging point passage permission request S3 made to the area controller 60 to the linear type, after passing through the merging point G from the curve route 43 and before passing through the post-merging point P4. With this configuration, when another following carriage 6C travels from the curve route 43 toward the merging point G, another following carriage 6C is kept waiting before the merging point G, and collision between the carriages 6 can be prevented. Another following carriage 6C waiting before the merging point G on the linear route 41 can obtain a merging point passage permission response S4 without waiting for the following carriage 6B to pass through the post-merging point P4. As a result, the transportation efficiency of the carriages 6 can be improved.

[0069] In the foregoing, the preceding carriage 6A corresponds to a first carriage and a fourth carriage. The following carriage 6B corresponds to a second carriage and a fifth carriage. Another following carriage 6C corresponds to a third carriage.

[0070] Although an embodiment has been described above, an aspect of the present invention is not limited to the foregoing embodiment and susceptible to various modifications without departing from the spirit of the present invention.

[0071] In the foregoing embodiment, the preceding carriage 6A or the following carriage 6B changes the type of the merging point passage permission request that the preceding carriage 6A or the following carriage 6B makes to the area controller 60, to the linear type, after passing through the merging point G from the curve route 43 and before passing through the post-merging point P4. However, instead of or in addition to the process of changing the type of the merging point passage permission request S3 to the linear type, the process of transmitting a signal to the area controller 60 to allow the area controller 60 to recognize that the type of the merging point passage permission request S3 received from the preceding carriage 6A or the following carriage 6B is the linear type may be performed. Also in this case, consequently, both of the types of the merging point passage permission requests received from the preceding carriage 6A and the following carriage 6B can be set to the linear type, or both of the types of the merging point passage permission requests received from the following carriage 6B and another following carriage 6C can be set to the linear type.

[0072] In the foregoing embodiment, an automated overhead traveling carriage is used as the carriage 6. However, the carriage 6 is not limited. The carriage 6 may be an overhead shuttle. The carriage 6 may be an automated rail-guided transport carriage that can travel along a track on the floor. The carriage 6 may be an automated magnetic-guided transport carriage that can travel along a path constructed with a magnetic tape or the like. The carriage 6 may be an automated laser-guided transport carriage that is guided by laser light to

travel along a predetermined path.

[0073] In the foregoing embodiment, one or more other controllers may be provided as a relay between the area controller 60 and the carriage 6. The components in the foregoing embodiment are not limited by materials and shapes, and various materials and shapes can be employed.

Reference Signs List

[0074] 1 ... traveling system, 4 ... track (traveling path), 6 ... carriage, 6A ... preceding carriage (first carriage, fourth carriage), 6B ... following carriage (second carriage, fifth carriage), 6C ... another following carriage (third carriage), 8 ... linear sensor (intercarriage sensor), 41 ... linear route (first linear traveling path), 42 ... linear route (second linear traveling path), 43 ... curve route (first curved traveling path, second curved traveling path), 60 ... area controller (controller), B ... branching point, G ... merging point, P4 ... post-merging point (predetermined point), S1 ... branching point passage permission request, S2 ... branching point passage permission response, S3 ... merging point passage permission request, S4 ... merging point passage permission response.

CLAIMS

1. A traveling system comprising:
a predetermined traveling path;
a plurality of carriages capable of traveling along the traveling
5 path; and

a controller configured to control the carriages, wherein
the traveling path includes a first linear traveling path and a first
curved traveling path merging through a merging point on a way of the
first linear traveling path,

10 the carriage transmits a merging point passage permission
request to request permission for passage through the merging point to
the controller before the merging point, enters the merging point when
receiving a merging point passage permission response indicating
permission for passage through the merging point from the controller,
15 and waits before the merging point when not receiving the merging
point passage permission response from the controller,

the carriage waiting before the merging point receives the
merging point passage permission response from the controller after the
carriage that immediately precedes the carriage waiting and has passed
20 through the merging point passes through a predetermined point,

the controller,

when the merging point passage permission requests are
received from a first carriage that is the carriage preceding and a second
carriage that is the carriage following the first carriage and when both of
25 types of the merging point passage permission requests received from
the first carriage and the second carriage are a linear type that is a type

of the merging point passage permission request at a time of moving from the first linear traveling path to the merging point, transmits the merging point passage permission response to the first carriage and the second carriage, and

5 when the merging point passage permission requests are received from the first carriage and the second carriage and when the type of the merging point passage permission request received from the first carriage is a curved type that is a type of the merging point passage permission request at a time of moving from the first curved traveling
10 path to the merging point, transmits the merging point passage permission response only to the first carriage, and

the first carriage making the merging point passage permission request of the curved type to the controller performs at least one of: a process of changing the type of the merging point passage permission
15 request made to the controller to the linear type; and a process of transmitting a signal to the controller to allow the controller to recognize that the type of the merging point passage permission request received from the first carriage is the linear type, after passing through the merging point from the first curved traveling path and before
20 passing through the predetermined point.

2. The traveling system according to claim 1, wherein
the controller

when the merging point passage permission request is received from a third carriage in addition to the first carriage and the
25 second carriage, the third carriage being the carriage following the second carriage and when all of the types of the merging point passage

permission requests received from the first carriage, the second carriage, and the third carriage are the linear type, transmits the merging point passage permission response to the third carriage in addition to the first carriage and the second carriage, and

5 when the merging point passage permission request is received from the third carriage in addition to the first carriage and the second carriage and when the type of at least one of the merging point passage permission requests received from the first carriage, the second carriage, and the third carriage is the curved type, transmits the merging
10 point passage permission response only to the first carriage, and

 the second carriage making the merging point passage permission request of the curved type to the controller performs at least one of: a process of changing the type of the merging point passage permission request made to the controller to the linear type; and a
15 process of transmitting a signal to the controller to allow the controller to recognize that the type of the merging point passage permission request received from the second carriage is the curved type, after passing through the merging point from the first curved traveling path and before passing through the predetermined point.

20 3. The traveling system according to claim 1 or 2, wherein when the merging point passage permission requests are received from the first carriage and the second carriage and when the type of the merging point passage permission request received from the first carriage is the linear type and the type of the merging point passage permission request
25 received from the second carriage is the curved type, the merging point passage permission response is transmitted only to the first carriage.

4. The traveling system according to any one of claims 1 to 3, wherein each of the carriages includes an intercarriage sensor configured to detect a distance from the carriage ahead.

5. The traveling system according to claim 4, wherein the intercarriage sensor is a linear sensor capable of detecting the carriage right in front.

6. The traveling system according to any one of claims 1 to 5, wherein

the traveling path includes a second linear traveling path, and a second curved traveling path splitting through a branching point on a way of the second linear traveling path and continuous to the first curved traveling path,

the carriage transmits a branching point passage permission request to request permission for passage through the branching point to the controller before the branching point, enters the branching point when receiving a branching point passage permission response indicating permission for passage through the branching point from the controller, and waits before the branching point when not receiving the branching point passage permission response from the controller, and

the controller,

when the branching point passage permission requests are received from a fourth carriage that is the carriage preceding and a fifth carriage that is the carriage following the fourth carriage and when the type of the branching point passage permission request received from the fourth carriage is a curved type that is a type of the branching point passage permission request at a time of moving from the

branching point to the second curved traveling path and the type of the branching point passage permission request received from the fifth carriage is a linear type that is a type of the branching point passage permission request at a time of moving from the branching point to the second linear traveling path, transmits the branching point passage permission response only to the fourth carriage, and

when the fourth carriage reaches a location where the fifth carriage does not interfere even when passing through the branching point, transmits the branching point passage permission response to the fifth carriage.