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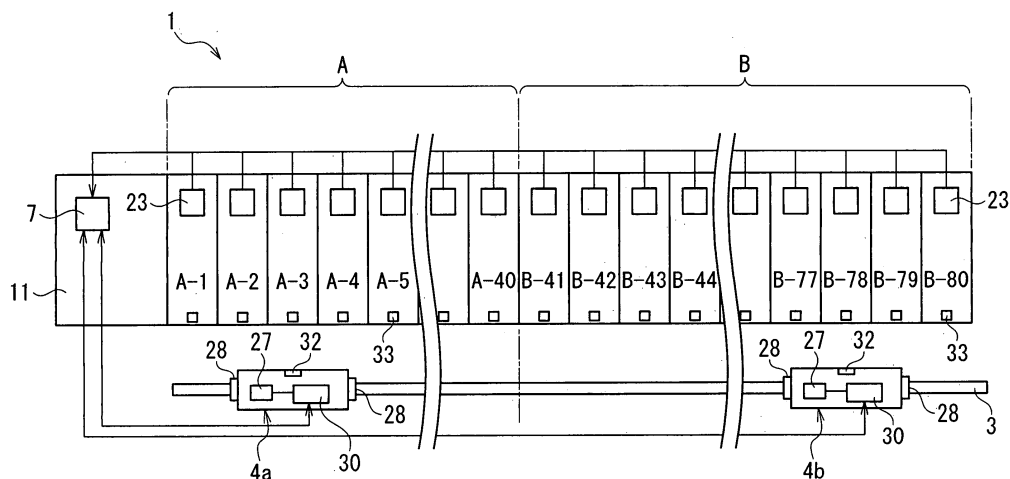
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(54) **Method for controlling work vehicles in yarn processing apparatus, and yarn processing apparatus**

(57) A method for controlling work vehicles in a yarn processing apparatus allows work vehicles to travel and move efficiently to execute service processes on units with a high work efficiency even if two units located at an mutually interfering position issue service processes, respectively. The area in which approaching work vehicles 4a, 4b may interfere with each other and fail to simultaneously execute an operational process is defined as the "interfering area" on the basis of the width dimensions of the unit 2 and the work vehicles 4a, 4b. When the two

units 2 simultaneously issue service process requests, respectively, the method determines, before traveling movement of the work vehicles 4a, 4b, whether the units 2 are in the mutual interference state, on the basis of the interfering area. Upon determining that the units 2 are in the mutual interference state, the method measures the distances from the current positions of the work vehicles 4a, 4b to the respective process requesting units 2, 2. Then, one of the work vehicles 4a, 4b which is closer to the corresponding process requesting unit 2 is preferentially allowed to execute a service process.

FIGURE 2



Description

Field of the Invention

[0001] The present invention relates to a method for controlling work vehicles in a yarn processing apparatus having a plurality of work vehicles guided and supported so that the work vehicles can travel freely, on one route provided along a direction in which yarn processing units are arranged, and also relates to the yarn processing apparatus. More specifically, the present invention relates to a technique used for the above method and apparatus which prevent a possible operational delay caused by mutual interference between two work vehicles to improve work efficiency.

Background of the Invention

[0002] A well-known example of a method for controlling work vehicles as described above is disclosed in the Unexamined Japanese Patent Application Publication (Tokkai-Hei) No. 6-108331. In a spinning machine described in the Unexamined Japanese Patent Application Publication (Tokkai-Hei) No. 6-108331, two work vehicles, a yarn splicing vehicle and a roving yarn splicing vehicle, are guided and supported on one route so as to be able to travel freely. To allow the opposite distance between the work vehicles to be measured, the work vehicles are each equipped with an obstacle sensor so that whenever the work vehicles approach each other, the roving yarn splicing vehicle is preferentially allowed to travel. This control method is superior in the ability to reliably prevent possible malfunctioning caused by a possible collision between the work vehicles.

[0003] However, with the above control method, when two units located in proximity to each other both issue service process requests, respectively, the work vehicles may perform useless traveling operations. This unavoidably and significantly reduces the work efficiency of the work vehicles. The control method thus has room for improvement in this regard.

[0004] In other words, the control method according to the Unexamined Japanese Patent Application Publication (Tokkai-Hei) No. 6-108331 cannot sense that the work vehicles are interfering with each other and cannot simultaneously perform their operations, until they approach each other to turn their obstacle sensors on. Thus, when two units located in an area in which mutual interference may occur both issue service process requests, respectively, then even though the two work vehicles cannot simultaneously perform their operations, the work vehicles may travel to the respective process requesting units or may each stop or travel in the opposite direction after approaching the other. That is, the work vehicles perform useless traveling operations. In the worst case, the work vehicles each keep away from the other to avoid contact and thus cannot reach the corresponding process requesting unit.

[0005] An object of the present invention is to solve the above problems to allow work vehicles to travel and move efficiently to execute service processes with a high work efficiency even if two units located at an interfering position issue service process requests, respectively.

Summary of the Invention

[0006] The invention set forth in Claim 1 provides a method for controlling work vehicles in a yarn processing apparatus comprising a plurality of yarn processing units arranged in a line, a route formed along a direction in which the units are arranged, and a plurality of work vehicles configured to travel along the route to execute a service process on the units, wherein a work area comprising a plurality of consecutive units is pre-assigned to each of the work vehicles, and in response to a service process request from a unit, the corresponding work vehicle travels within the route to execute a service process on the unit belonging to the work area for which the work vehicle is responsible, and the size of an area in which two work vehicles approaching each other interfere with each other is pre-defined as an interfering area on the basis of the width dimension of the unit and the width dimension of the work vehicle in a direction in which the route extends.

[0007] The method includes a distance measuring step of measuring distances from current positions of the work vehicles to respective process requesting units when at least two units belonging to respective adjacent different work areas issue service process requests, respectively, resulting in a plurality of process requesting units having issued the service process requests, and a determining step of, immediately before or after the distance measuring step, determining whether or not service processes executed on the two process requesting units by the two work vehicles cause mutual interference between the two work vehicles, on the basis of the interfering area determined by each process requesting unit, and in that when the determining step determines the possible occurrence of mutual interference between the two work vehicles, one of the work vehicles is determined to be closer to the corresponding process requesting unit on the basis of the measurement result in the distance measuring step, and a service process is preferentially executed by the determined work vehicle.

[0008] Specific examples of the yarn processing apparatus include a pneumatic spinning apparatus and an automatic winder. Specific examples of the service process executed by the work vehicles include a yarn splicing process, a doffing process and so on.

[0009] According to the present invention, as set forth in Claim 2, the method may further include a mask processing step of, on the basis of the measurement result in the distance measuring step, determining one of the work vehicles which is closer to the corresponding process requesting unit to be a preferential vehicle and determining the other work vehicle which is farther from

the corresponding process requesting unit to be a following vehicle, and determining the units belonging to the interfering area based on the process requesting unit which is to get the service provided by the preferential vehicle to mask service requests from the units belonging to the interfering area to the following vehicle.

[0010] According to the present invention, as set forth in Claim 3, desirably, in the mask processing step, while the preferential vehicle is executing a service process on the corresponding process requesting unit, the following vehicle waits away from but as close as possible to the interfering area based on the process requesting unit which is to get the service provided by the preferential vehicle.

[0011] According to the present invention, as set forth in Claim 4, desirably, once the preferential vehicle finishes the service process on the corresponding process requesting unit, the preferential vehicle immediately leaves the interfering area determined on the basis of the process requesting unit desiring the following vehicle to execute a service process thereon.

[0012] The invention set forth in Claim 5 provides a yarn processing apparatus comprising a plurality of yarn processing units arranged in a line, a route formed along a direction in which the units are arranged, a plurality of work vehicles configured to travel along the route to execute a service process on the units, distance measuring means for measuring a distance from a current position of each work vehicle to a unit having issued a process request, and control means for controlling the work vehicles.

[0013] The size of an area in which two work vehicles approaching each other interfere with each other is pre-defined as an interfering area on the basis of the width dimension of the unit and the width dimension of the work vehicle in a direction in which the route extends.

[0014] When two units located in proximity to each other across a boundary between adjacent different work areas issue service process requests, respectively, resulting in a plurality of process requesting units having issued the service process requests, the control means determines whether or not service processes executed by the two work vehicles cause mutual interference on the basis of the interfering area, and upon determining the possible occurrence of mutual interference from the determination result, the control means allows the distance measuring means to measure the distances from the current positions of the work vehicles to the respective process requesting units, and on the basis of the measurement result, allows one of the work vehicles which is closer to the corresponding process requesting unit to preferentially execute a service process.

[0015] According to the present invention, as set forth in Claim 6, each work vehicle comprises a control device that controls traveling movement of the own work vehicle, and the control means may comprise the control devices. On the basis of the measurement result provided by the distance measuring means, the control devices deter-

mine one of the work vehicles which is closer to the corresponding process requesting unit to be a preferential vehicle and determine the other work vehicle which is farther from the corresponding process requesting unit to be a following vehicle, and on the basis of the position of the process requesting unit that is to get the service provided by the preferential vehicle, the control devices determine the units that the following vehicle is disabled to process as a result of the mutual interference between the preferential vehicle and the following vehicle and mask service requests from the units that the following vehicle is disabled to process to limit the unit on which the following vehicle is allowed to execute a service process.

[0016] The controlling method in accordance with the present invention set forth in Claim 1, when two units issue service process requests, respectively, determines whether or not mutual interference will occur between two work vehicles that execute a service process on the respective units, on the basis of the interfering area pre-defined on the basis of the width dimensions of the unit and the work vehicle. This makes it possible to determine whether or not the two work vehicles will interfere with each other on the basis of the interfering area without the need to cause the work vehicles to travel and move. This in turn prevents the work vehicles from traveling uselessly as is the case with the controlling method described in the Unexamined Japanese Patent Application Publication (Tokkai-Hei) No. 6-108331; with this method, in spite of a mutual interference state in which the two work vehicles cannot simultaneously perform their operations, the work vehicles may travel to the respective process requesting units or may each stop or travel in the opposite direction after approaching the other. The work vehicles can thus travel efficiently to execute a service process with a high work efficiency. This makes it possible to contribute to improving the utilization rate of the yarn processing units and thus the processing ability of the yarn processing apparatus.

[0017] Further, one of the work vehicles which is closer to the corresponding process requesting unit is preferentially allowed to execute a service process. This enables a reduction in the time required to move from a wait position of the work vehicle to the process requesting unit. This means the ability to allow the work vehicle to travel efficiently to quickly start a service process. This makes it possible to contribute to improving the work efficiency of the work vehicles and thus the processing ability of the yarn processing apparatus.

[0018] According to the present invention, as set forth in Claim 2, the units that are to belong to the interfering area are determined on the basis of the process requesting unit that is to get the service provided by the preferential vehicle, and are then masked the service request from the process requesting unit. Thus, while the preferential vehicle is executing a service process on the corresponding process requesting unit, the following vehicle can be efficiently assigned to a service process to be

executed on another unit different from the masked units. This enables the following vehicle to smoothly and efficiently execute a service process, contributing to the improvement of yarn processing ability of the yarn processing apparatus.

[0019] According to the present invention, as set forth in Claim 3, while the preferential vehicle is executing a service process on the corresponding process requesting unit, the following vehicle waits away from the interfering area for the corresponding process requesting unit but as close as possible to the unit to be processed by the following vehicle. Thus, when the preferential vehicle finishes the service process on the corresponding process requesting unit to cancel the mask process, the following vehicle can be immediately moved to the work position of the corresponding process requesting unit. This enables the following vehicle to immediately start a service process on the corresponding process requesting unit. This in turn makes it possible to contribute to improving the work efficiency of the work vehicles and thus the yarn processing ability of the yarn processing apparatus.

[0020] According to the present invention, as set forth in Claim 4, upon finishing the service process on the corresponding process requesting unit, the preferential vehicle leaves the interfering area determined on the basis of the process requesting unit that desires the following vehicle to execute a service process thereon. Then, the following vehicle can immediately move to the work position of the corresponding process requesting unit. This also makes it possible to contribute to improving the work efficiency of the work vehicles and thus the yarn processing ability of the yarn processing apparatus.

[0021] The yarn processing apparatus in accordance with the present invention set forth in Claim 5 exerts effects similar to those of the controlling method in accordance with Claim 1 of the present invention. That is, when two units issue service process requests, respectively, the apparatus determines whether or not mutual interference will occur between the two work vehicles that execute a service process on the respective units, on the basis of the interfering area pre-defined on the basis of the width dimensions of the unit and the work vehicle. This makes it possible to determine whether or not the two work vehicles will interfere with each other on the basis of the interfering area without the need to cause the work vehicles to travel and move. This in turn prevents the work vehicles from traveling uselessly as is the case with the controlling method described in the Unexamined Japanese Patent Application Publication (Tokkai-Hei) No. 6-108331; with this method, in spite of the mutual interference state in which the two work vehicles cannot simultaneously perform their operations, the work vehicles may travel to the respective process requesting units or may each stop or travel in the opposite direction after approaching the other. The work vehicles can thus travel efficiently to execute a service process with a high work efficiency. This makes it possible to contribute to improv-

ing the utilization rate of the yarn processing units and thus the processing ability of the units.

[0022] Further, one of the work vehicles which is closer to the corresponding process requesting unit is preferentially allowed to execute a service process. This enables a reduction in the time required to move from a wait position of the work vehicle to the process requesting unit. This means the ability to allow the work vehicle to travel efficiently to quickly start a service process. This makes it possible to contribute to improving the work efficiency of the work vehicles and thus the processing ability of the yarn processing apparatus.

[0023] According to the present invention, as set forth in Claim 6, the units, which are to belong to the interfering area, are determined on the basis of the process requesting unit that is to get the service provided by the preferential vehicle, and are then masked the service request from the process requesting unit. Thus, while the preferential vehicle is executing a service process on the corresponding process requesting unit, the following vehicle can be efficiently assigned to a service process to be executed on another unit different from the masked units. This enables the following vehicle to smoothly and efficiently execute a service process, contributing to the improvement of yarn processing ability of the yarn processing apparatus.

[0024] Further, according to the present invention, as set forth in Claim 6, the control device provided in each work vehicle controls the traveling movement of the work vehicle. The processing ability required for this control device is lower than that required in the case where a single control device provided in the main body of the yarn processing apparatus controls all the work vehicles. This eliminates the need for an expensive control device with high operating ability, contributing to a reduction in the manufacturing cost of the yarn processing apparatus. This arrangement also enables a faster process than that in which the single control device controls a plurality of work vehicles. Therefore, this arrangement is also excellent in the ability to improve the processing ability.

[0025] Other features, elements, processes, steps, characteristics and advantages of the present invention will become more apparent from the following detailed description of preferred embodiments of the present invention with reference to the attached drawings.

Brief Description of the Drawings

[0026]

Figure 1 is a front view of a pneumatic spinning machine to which a controlling method in accordance with the present invention is applied.

Figure 2 is a schematic plan view showing the general configuration of the pneumatic spinning machine.

Figure 3 is a block diagram showing the electrical configuration of the pneumatic spinning machine.

Figure 4 is a diagram illustrating a mutual interference state.

Figure 5 is a diagram illustrating an interfering area.

Figure 6 is a diagram illustrating a controlling method.

Detailed Description of the Preferred Embodiments

[0027] With reference to the drawings, a description will be given of an embodiment in which a method for controlling work vehicles in a yarn processing apparatus as well as the yarn processing apparatus in accordance with the present invention are applied to a pneumatic spinning machine.

[0028] Figure 1 is a front view of a pneumatic spinning machine, Figure 2 is a schematic plan view showing the general configuration of the pneumatic spinning machine, and Figure 3 is a block diagram showing the electrical configuration of the pneumatic spinning machine.

[0029] The pneumatic spinning machine 1 is composed of 80 spinning units (yarn processing units) 2 arranged in a longitudinal direction of a machine frame 6, a vertical pair of routes 3, 3 formed along a direction in which the units 2 are arranged, and two work vehicles 4a, 4b guided and supported so that the work vehicles 4a, 4b can travel freely along the routes 3, 3 to execute a service process on the units 2. In the present embodiment, the direction in which the units 2 are arranged is defined as a lateral direction. The position at which the routes 3, 3 are disposed as viewed from the units 2 is defined as a front position.

[0030] Each of the units 2 is a device that allows a winding device 13 to wind a yarn 10 spun out of a spinning member (not shown in the drawings) into a package. A driving box 11 with a built-in central control device 7 is provided at a laterally one end of the machine frame 6, and a blower box 12 is provided at the other end.

[0031] The machine frame 6 is configured to have a C-shaped cross section which is open on its side closer to a route for the yarn 10 and in which an elongate traveling space 15 is formed. The vertically paired routes 3, 3 are disposed inside the traveling space 15 parallel to each other so as to extend in the lateral direction. The two self-propelled work vehicles 4a, 4b can reciprocate along the routes 3, 3 in the lateral direction. Each of the work vehicles 4a, 4b has a housing 18 having a yarn splicing device 21 such as a splicer or a knitter and travel driving wheels 19 that allows the housing 18 to travel drivingly. The housing 18 has not only the yarn splicing device 21 but also a movable suction pipe through which a yarn end is drawn out from the spinning member side and the winding device 13 side and delivered to the yarn splicing device 21.

[0032] When yarn breakage occurs in any of the units 2, on the basis of a control signal from the central control device 7, one of the work vehicles 4a, 4b can drive the travel driving wheels 19 via a motor 27 (see Figure 3) to travel to and stop at the unit 2. The work vehicle 4a, 4b

can then drive the suction pipe and the yarn splicing device 21 to perform a yarn splicing operation.

[0033] As shown in Figure 2, each of the work vehicles 4a, 4b has collision preventing sensors 28 at its lateral ends. When the value of the opposite distance between the work vehicles 4a, 4b measured by the sensors 28 is smaller than a predetermined one, both work vehicles 4a, 4b are urgently stopped. In Figure 3, reference numeral 29 is a dog sensor that senses a dog (not shown in the drawings) provided on each of the units 2. Reference numeral 30 is a control device that controls each of the work vehicles 4a, 4b.

[0034] As shown in Figure 2, the 80 units 2, arranged in the lateral direction, are sequentially provided with unit numbers 1, 2, ... 79, and 80 starting from one end (left end) of the machine frame 6 of the spinning machine 1.

[0035] The first work vehicle 4a (hereinafter sometimes referred to as the first vehicle) located closer to the left end of the route 3, is responsible for service processes executed on the units 2 provided with unit numbers 1 to 40. The second work vehicle 4b (hereinafter sometimes referred to as the second vehicle) located closer to the right end of the route 3, is responsible for service processes executed on the units 2 provided with unit numbers 41 to 80.

[0036] In other words, a work area A composed of the 40 units 2 with unit numbers 1 to 40 is pre-assigned to the first vehicle 4a. A work area B composed of the 40 units 2 with unit numbers 41 to 80 is pre-assigned to the second vehicle 4b. The work vehicles 4a, 4b travel and move within the route 3 to execute a service process on the units 2 belonging to the work areas A, B, respectively.

[0037] In the description below, the units 2 with unit numbers 1 to 40, which belong to the work area A and on which the first work vehicle 4a executes a service process, are appropriately referred to as units (A-1) to (A-40). The units 2 with unit numbers 41 to 80, which belong to the work area B and on which the second work vehicle 4b executes a service process, are referred to as units (B-41) to (B-80).

[0038] The unit number of each unit 2 is stored in a control device 23 (see Figure 3), and the unit number is contained in a signal (service request signal) for a service process transmitted from the unit 2 to the central control device 7. On the basis of information on the unit number, the central control device 7 can determine which unit 2 has issued the service process request.

[0039] A position detecting function section is provided between the work vehicles 4a, 4b and the units 2 to sense the current positions of the work vehicles 4a, 4b. The position detecting function section in accordance with the present embodiment is composed of signal output sections 32 each placed on the bottom surface of the corresponding one of the work vehicles 4a, 4b and comprising a coil that outputs magnetic signals to the units 2, and signal receiving sections 33 each provided in the front of the corresponding one of the units 2 and comprising a receiving element that receives signals from the signal

output section 32.

[0040] When the work vehicle 4a or 4b arrives and stops at the front of the target unit 2, the control device 30 of the work vehicle 4a or 4b drives the signal output section 32 to output an instruction signal instructing the unit 2 to return its unit number. The unit 2 with the signal receiving section 33 having received the instruction signal transmits a response signal containing its own unit number to the control device 30 of the work vehicle 4a or 4b via the central control device 7. On the basis of the response signal, the stopped work vehicle 4a or 4b can determine which one of the units 2 the work vehicle 4a or 4b is stopped to face. That is, the work vehicle 4a or 4b can obtain information on its own current position. After starting to travel, the work vehicle 4a or 4b counts the number of dogs sensed by the dog sensor 29 to calculate the number of units 2 by which it has passed during traveling. The work vehicle 4a or 4b thus determines the distance from the position where it was stopped so that the work vehicle 4a or 4b can determine the current position during traveling by combining the distance with the above-obtained current position information. Upon determining that the work vehicle 4a or 4b has arrived at the front of the target unit 2 and stopping driving the motor 27 to halt itself, the work vehicle 4a or 4b transmits a signal to the signal receiving section 33 of the unit 2 again. Then, on the basis of a response signal returned by the unit 2 in response to the transmitted signal, the work vehicle 4a or 4b can accurately determine its own current position. The series of position-determining operations thus described enable the work vehicle 4a or 4b to determine exactly where it locates at the moment.

[0041] As shown in Figure 1 and Figure 3, these units 2 are consecutively juxtaposed without any space between them. The width dimension of each of the work vehicles 4a, 4b is larger than the width dimension of each unit 2. Thus, when the two work vehicles 4a, 4b attempt to simultaneously execute respective service processes on the two units 2, 2 located in proximity to each other across the boundary between the work areas, the work vehicles 4a, 4b may interfere with each other and cannot execute respective service processes (this state is hereinafter referred to as a mutual interference state).

[0042] For example, as shown in Figure 4, when service process requests are issued by the unit 2 A-40 located at the right end of the work area A and the unit 2 B-41 located at the left end of the work area B, the mutual interference between the work vehicles 4a, 4b makes it physically impossible to arrange the work vehicles 4a, 4b at the fronts of the two units (A-40, B-41). Thus, the work vehicles 4a, 4b cannot simultaneously execute respective service processes on the units (A-40, B-41).

[0043] In the pneumatic spinning device 1, to determine whether or not the above mutual interference will occur, the size of the area in which the work vehicles 4a, 4b may interfere with each other is pre-defined as an "interfering area" in terms of the units on the basis of the lateral width dimension of the unit 2 and the lateral width

dimension of the work vehicle 4a, 4b. In the present embodiment, the units within three ranges based on a process requesting unit are defined as an interfering area.

[0044] Specifically, as shown in Figure 5A, when the second vehicle 4b is positioned in front of the unit (B-41), the first vehicle 4a cannot be positioned in front of the unit (A-38), the unit (A-39), or the unit (A-40). Accordingly, when the unit (B-41) issues a service process request, the central control device 7 defines the unit (A-38), the unit (A-39), and the unit (A-40) as an interfering area.

[0045] Similarly, as shown in Figure 5B, when the unit (B-43) issues a service process request, the central control device 7 defines the unit (A-40), the unit (B-41), and the unit (B-42) as an interfering area. However, in view of the work area A, on which the first vehicle 4a is responsible for executing a service process, substantially only the unit (A-40) constitutes the interfering area.

[0046] As shown in Figure 5C, when the unit (A-39) issues a service process request, the central control device 7 defines the unit (A-40), the unit (B-41), and the unit (B-42) as an interfering area. However, in view of the work area B, on which the second vehicle 4b executes a service process, substantially the unit (B-41) and the unit (B-42) constitute the interfering area.

[0047] Now, with reference to Figure 6, a description will be given of a specific method for controlling the work vehicles 4a, 4b in the pneumatic spinning machine 1 configured as described above.

[0048] Now, it is assumed that the first vehicle 4a is executing a service process on the unit (A-30), while the second vehicle 4b is executing a service process on the unit (B-48), as shown in Figure 6. It is further assumed that in this state, before the vehicles 4a, 4b finish the service processes, four units 2 (A-39, A-15, and B-41, B-60) have issued service process requests, respectively.

[0049] Upon receiving service process requests, the control devices 30 of the work vehicles 4a, 4b actuate the position detecting function sections to determine which of the process requesting units is closer to its current position (distance measuring step).

[0050] Specifically, the control device 30 calculates the distance from the current position (unit A-30) of the first vehicle 4a to the unit (A-39) and the distance from the current position (unit A-30) to the unit (A-15) to determine which of the units is closer to the current position. Here, the distance from unit A-30 to unit A-39 corresponds to 9 units, and the distance from unit A-30 to unit A-15 corresponds to 15 units. The control device 30 thus determines that the unit (A-39) is closer to the current position (unit A-30). Similarly, the control device 30 calculates and compares the distance from the current position (unit B-48) of the second vehicle 4b to the unit (B-41) (this distance corresponds to 7 units) and the distance from the current position (unit B-48) to the unit (B-60) (this distance corresponds to 12 units) to determine that the unit (B-41) is closer to the current position (unit B-48).

[0051] That is, this situation brings the mutual interference state. The process requesting unit (B-41) of the

second vehicle 4b is positioned in the interfering area based on the process requesting unit (A-39) of the first vehicle 4a. At the same time, the process requesting unit (A-39) of the first vehicle 4a is positioned in the interfering area based on the process requesting unit (B-41) of the second vehicle 4b.

[0052] However, when the work vehicles 4a, 4b are allowed to travel and move only on the basis of the independent and separate distance measurement results calculated for each of the work vehicles 4a, 4b, in some cases the selected units 2, 2 happen to be positioned in proximity to each other and are thus in the mutual interference state. In that state, one of the work vehicles 4a, 4b needs to move away, and therefor, one of the traveling movements is useless. Consequently, the work efficiency of the service process decreases unavoidably. That is, in spite of movement of the work vehicle 4a to the unit (A-39) and the work vehicle 4b to the unit (B-41) based only on the independent and separate distance measurement results, it is physically impossible to simultaneously execute a service process on both the unit (A-39) and the unit (B-41) (see Figure 5A and Figure 5C).

[0053] Thus, the control devices 30 of the work vehicles 4a, 4b determine whether or not the units are in the "mutual interference state" on the basis of the previously described "interference area" (determining step). Where the control devices 30 of the work vehicles 4a, 4b determine that the units are in the "mutual interference state", it compares the distances from the current positions of the work vehicles 4a, 4b to the respective process requesting units. The control devices 30 then determine one of the work vehicles 4a, 4b which is closer to the corresponding process requesting unit to be a preferential vehicle, while determining the other work vehicle to be a following vehicle. The control devices 30 then preferentially allow the preferential vehicle to execute a service process, preventing the possible interference between the work vehicles 4a, 4b.

[0054] That is, in the aspect shown in Figure 6, the distance from the current position (A-30) of the first vehicle 4a to the process requesting unit (A-39) corresponds to 9 units, and the distance from the current position (B-48) of the second vehicle 4b to the process requesting unit (B-41) corresponds to 7 units. Accordingly, the second work vehicle 4b is determined to be a preferential vehicle, while the first work vehicle 4a is determined to be a following vehicle. Then, the second vehicle 4b, the preferential vehicle, is permitted to travel and move to the front of the process requesting unit (B-41). The second work vehicle 4b is thus preferentially allowed to execute a service process on the unit (B-41).

[0055] Once the preferential vehicle 4b and the process requesting unit 2 to be preferentially served are thus determined, the units that are disabled to be processed are determined on the interfering area, and service requests from these units are masked (mask processing step). That is, in the aspect shown in Figure 6, the unit (A-38), the unit (A-39), and the unit (A-40) are determined

to belong to the interfering area on the basis of the unit (B-41) (see Figure 5A), and with the service requests from these three units masked, the unit on which the first vehicle 4a can execute a service process is limitedly determined among the units excluding these three units. The term "mask" as used herein means exclusion, disregard, hiding, and the like.

[0056] Since the process requesting unit (A-39) is one of the masked units, the first vehicle 4a, the following vehicle, postpones the execution of a service process on the process requesting unit (A-39) and moves to the front of the unit (A-15) to execute a service process. That is, the first vehicle 4a moves from the front of the unit (A-30), corresponding to the current position, to the front of the unit (A-15), a processing target unit, to execute a service process.

[0057] When the first work vehicle 4a finishes the service process on the unit (A-15), with the mask process in the mask processing step not cancelled yet, and any of the units (A-1 to A-37) other than the units (A-38 to A-40), which are limited by the mask process, issues a service process request, the first vehicle 4a executes a service process on this unit (A-1 to A-37).

[0058] When the first vehicle 4a finishes the service process on the unit (A-15), with the mask process in the mask processing step not cancelled yet, and none of the other units (A-1 to A-37) issues a service process request, the first vehicle 4a travels to the processing target unit (A-39) and waits as close as possible to the unit (A-39) and away from the area in which the first work vehicle 4a and the second work vehicle 4b may interfere with each other. In the present embodiment, since the interfering area based on the unit (B-41) corresponds to the positions in front of the unit (A-38) to the unit (A-40), the first work vehicle 4a waits in front of the unit (A-37) (see Figure 5A). Once the second vehicle 4b finishes the service process on the unit (B-41), the second vehicle 4b immediately leaves the interfering area (see Figure 5C) for the unit (A-39), which is the process requesting unit, and moves to the unit (B-60) for a service process. In conjunction with the leaving operation, the first vehicle 4a moves to the front of the unit (A-39) to execute a service process.

[0059] When the second vehicle 4b finished the service process on the unit (B-41) before the first vehicle 4a reaches the vicinity of the unit (A-39) following the completion of the service process by the the first vehicle 4a on the unit (A-15), then of course, the first unit 4a moves to the front of the unit (A-39) without waiting to execute a service process.

[0060] As described above, in the method for controlling work vehicles in accordance with the present embodiment, the size of the area in which the approaching work vehicles 4a, 4b may interfere with each other and fail to simultaneously execute respective operational processes on the corresponding units is defined as the "interfering area" on the basis of the width dimensions of the unit 2 and the work vehicles 4a, 4b. When the two

units 2, 2 simultaneously issue service process requests, the method determines, before traveling movement of the work vehicles 4a, 4b, whether the units 2, 2 are in the mutual interference state, on the basis of the interfering area. Upon determining that the units 2, 2 are in the mutual interference state, the method measures the distances from the current positions of the work vehicles 4a, 4b to the respective process requesting units 2, 2. Then, one of the work vehicles 4a, 4b which is closer to the corresponding process requesting unit 2 is preferentially allowed to execute a service process.

[0061] Therefore, this controlling method eliminates unnecessary traveling of the work vehicles 4a, 4b, which traveling would be found in the situation where in spite of the mutual interference state, the work vehicles 4a, 4b travel to the respective process requesting units 2 or each stop or travel in a reverse direction after approaching the other. The controlling method thus enables the work vehicles 4a, 4b to travel and move efficiently. This allows the work vehicles 4a, 4b to move appropriately and quickly to the fronts of the respective process requesting units 2 to smoothly execute respective service processes. This in turn makes it possible to contribute to improving the utilization rate of the units 2 and thus the processing ability of the yarn processing apparatus.

[0062] Further, one of the work vehicles 4a, 4b which is closer to the corresponding process requesting unit 2 is preferentially allowed to execute a service process. This enables a reduction in the time required for the work vehicles 4a, 4b to travel and move from the wait positions to the respective process requesting units 2. This means that the work vehicles 4a, 4b can be allowed to travel efficiently to quickly start a service process. Therefore, also in this regard, the present invention can contribute to improving the work efficiency of the work vehicles 4a, 4b and thus the yarn processing ability of the pneumatic spinning machine.

[0063] For the definition of the interfering area, a predetermined length (in meters) from a process requesting unit in the lateral direction may be defined as an interfering area. However, this makes it necessary to actually measure and keep track of the distances that the work vehicles 4a, 4b have moved. This unavoidably complicates the process of determining whether or not the work vehicles 4a, 4b have reached the interfering area. A special separate device that actually measures the distances is required, advantageously increasing the general costs of the yarn processing apparatus.

[0064] In contrast, defining the interfering area in terms of the units as in the present embodiment makes it possible to easily and reliably sense that the work vehicles 4a, 4b have reached their positions away from the interfering area. The position detecting function section, composed of the signal output sections 32 and the signal receiving sections 33, can be used to sense that the work vehicles 4a, 4b have reached their positions away from the interfering area. The present embodiment is thus excellent in the ability to inhibit an increase in the manufac-

turing cost of the yarn processing apparatus to provide an inexpensive yarn processing apparatus.

[0065] The service requests from the units 2 that are to belong to the interfering area are masked. Then, while the preferential vehicles is executing a service process on the corresponding process requesting unit 2, the following vehicle can be assigned to a service process on a different unit 2 other than the masked unit(s) 2. This makes it possible to contribute to improving the work efficiency of the following work vehicle and thus the yarn processing ability of the pneumatic spinning machine.

[0066] While the preferential vehicle is executing a service process on the corresponding process requesting unit, the following vehicle waits away from the interfering area for the process requesting unit 2 but as close as possible to the processing target unit. Then, when the preferential vehicle finishes the service process on the corresponding process requesting unit 2 to cancel the mask process, the following vehicle can be immediately moved to a work position of the corresponding processing target unit. This enables the following vehicle to immediately start a service process on the corresponding process requesting unit 2. This in turn makes it possible to contribute to improving the work efficiency of the work vehicles 4a, 4b and the yarn processing ability of the yarn processing apparatus.

[0067] Upon finishing the service process on the corresponding process requesting unit 2, the preferential vehicle immediately leaves the interfering area based on the process requesting unit that desires the following vehicle to execute a service process thereon. Then, the following vehicle can immediately move to the work position of the corresponding process requesting unit. This makes it possible to contribute to improving the work efficiency of the work vehicles and the processing ability of the yarn processing apparatus.

[0068] In the description of the example in the above embodiment, service process requests are issued by the four units 2 (A-39, A-15 and B-41, B-60) before the first vehicle 4a and the second vehicle 4b have finished a service process on unit (A-30) and unit (B-48), respectively. However, the present invention is not limited to this. That is, the distance measuring step in accordance with the present invention has only to be executed where the interfering area may cover the work area of the other work vehicle. The execution of the distance measuring step does not depend on whether the work vehicles 4a, 4b are performing an operation or are traveling.

[0069] In an example of the aspect in Figure 6, the distance measuring step may be executed when two units interfering with each other such as the unit (A-39) and the unit (B-41) simultaneously issue service process requests, respectively. The term "simultaneously" means that after the unit (A-39) issues a service process request, the unit (B-41) also issues a service process request, and the service process requests are obtained from both the unit (A-39) and the unit (B-41). Specifically, for example, it is assumed that in order to execute a service

process on the unit (A-39), the first vehicle 4a travels from left to right to reach the position of the unit (A-30), when the unit (B-41) issues a service process request. Then, it is also possible to determine and compare the distance from the first vehicle 4a located at the position of the unit (A-30) to the unit (A-39) and the distance from the second vehicle 4b located at the position of the unit (B-48) to the unit (B-41), to determine the second vehicle 4b to be the preferential vehicle.

[0070] In the above embodiments, at most three consecutive units 2 each adjacent right and/or left to a process requesting unit 2 are defined as an interfering area. However, the present invention is not limited to this. At least four consecutive units each adjacent right and/or left to a process requesting unit 2 or only one unit each adjacent right/left to a process requesting unit 2 may be defined as an interfering area. This is because the interfering area is defined depending on the lateral width dimensions of the unit 2 and the work vehicles 4a, 4b.

[0071] The number of yarn processing units provided in the yarn processing apparatus is not limited to 80. The number may be equal to or larger than 80 or may be equal to or smaller than 80. Similarly, the number of work vehicles supported to travel freely on the route is not limited provided that the number is at least 2.

[0072] The position detecting function section, which senses the current positions of the work vehicles 4a, 4b, is not limited to the one composed of magnetic elements and receiving elements as described above. For example, the position detecting function section may transmit and receive signals by means of radio communication.

[0073] While the present invention has been described with respect to preferred embodiments thereof, it will be apparent to those skilled in the art that the disclosed invention may be modified in numerous ways and may assume many embodiments other than those specifically set out and described above. Accordingly, it is intended by the appended claims to cover all modifications of the present invention that fall within the true spirit and scope of the invention.

Claims

1. A method for controlling work vehicles in a yarn processing apparatus comprising a plurality of yarn processing units arranged in a line, a route formed along a direction in which the units are arranged, and a plurality of work vehicles configured to travel along the route to execute a service process on the units, the method being **characterized in that**:

a work area comprising a plurality of consecutive units is pre-assigned to each of the work vehicles, and in response to a service process request from a unit, the corresponding work vehicle travels within the route to execute a service process on the unit belonging to the work area

for which the work vehicle is responsible, the size of an area in which two work vehicles approaching each other interfere with each other is pre-defined as an interfering area on the basis of the width dimension of the unit and the width dimension of the work vehicle in a direction in which the route extends,

the method comprises a distance measuring step of measuring distances from current positions of the work vehicles to respective process requesting units when at least two units belonging to respective adjacent different work areas issue service process requests, respectively, resulting in a plurality of process requesting units having issued the service process requests, and a determining step of, immediately before or after the distance measuring step, determining whether or not service processes executed on the two process requesting units by the two work vehicles cause mutual interference between the work vehicles, on the basis of the interfering area, and

when the determining step determines the possible occurrence of mutual interference between the two work vehicles, one of the work vehicles is determined to be closer to the corresponding process requesting unit on the basis of the measurement result in the distance measuring step, and a service process is preferentially executed by the determined work vehicle.

2. A method for controlling work vehicles in a yarn processing apparatus according to Claim 1, **characterized by** further comprising:

a mask processing step of, on the basis of the measurement result in the distance measuring step, determining one of the work vehicles which is closer to the corresponding process requesting unit to be a preferential vehicle and determining the other work vehicle which is farther from the corresponding process requesting unit to be a following vehicle, and determining the units belonging to the interfering area based on the process requesting unit which is to get the service provided by the preferential vehicle to mask service requests from the units belonging to the interfering area to the following vehicle.

3. A method for controlling work vehicles in a yarn processing apparatus according to Claim 2, **characterized in that** in the mask processing step, while said preferential vehicle is executing a service process on the corresponding process requesting unit, the following vehicle waits away from but as close as possible to the interfering area based on the process requesting unit which is to get the service pro-

vided by the preferential vehicle.

4. A method for controlling work vehicles in a yarn processing apparatus according to any one of Claims 1 to 3, **characterized in that** once the preferential vehicle finishes the service process on the corresponding process requesting unit, the preferential vehicle immediately leaves the interfering area based on the process requesting unit desiring the following vehicle to execute a service process thereon. 5 10
5. A yarn processing apparatus comprising a plurality of yarn processing units arranged in a line, a route formed along a direction in which the units are arranged, a plurality of work vehicles configured to travel along the route to execute a service process on the units, distance measuring means for measuring a distance from a current position of each work vehicle to a unit having issued a process request, and control means for controlling the work vehicles, the apparatus being **characterized in that:** 15 20

the size of an area in which two work vehicles approaching each other interfere with each other is pre-defined as an interfering area on the basis of the width dimension of the unit and the width dimension of the work vehicle in a direction in which the route extends, and when two units located in proximity to each other across a boundary between adjacent different work areas issue service process requests, respectively, resulting in a plurality of process requesting units having issued the service process requests, the control means determines whether or not service processes executed by the two work vehicles cause mutual interference on the basis of the interfering area, and upon determining the possible occurrence of mutual interference from the determination result, the control means allows the distance measuring means to measure the distances from the current positions of the work vehicles to the respective process requesting units, and on the basis of the measurement result, allows one of the work vehicles which is closer to the corresponding process requesting unit to preferentially execute a service process. 25 30 35 40 45

6. A yarn processing apparatus according to Claim 5, **characterized in that:** 50

each work vehicle comprises a control device that controls traveling movement of the own work vehicle, and said control means comprises the control devices, on the basis of the measurement result provided by said distance measuring means, the control devices determine one 55

of the work vehicles which is closer to the corresponding process requesting unit to be a preferential vehicle and determine the other work vehicle which is farther from the corresponding process requesting unit to be a following vehicle, and

on the basis of the position of the process requesting unit that is to get the service provided by said preferential vehicle, said control devices determine the units that the following vehicle is disabled to process as a result of the mutual interference between the preferential vehicle and the following vehicle and mask service requests from the units that the following vehicle is disabled to process to limit the unit on which the following vehicle is allowed to execute a service process.

FIGURE 1

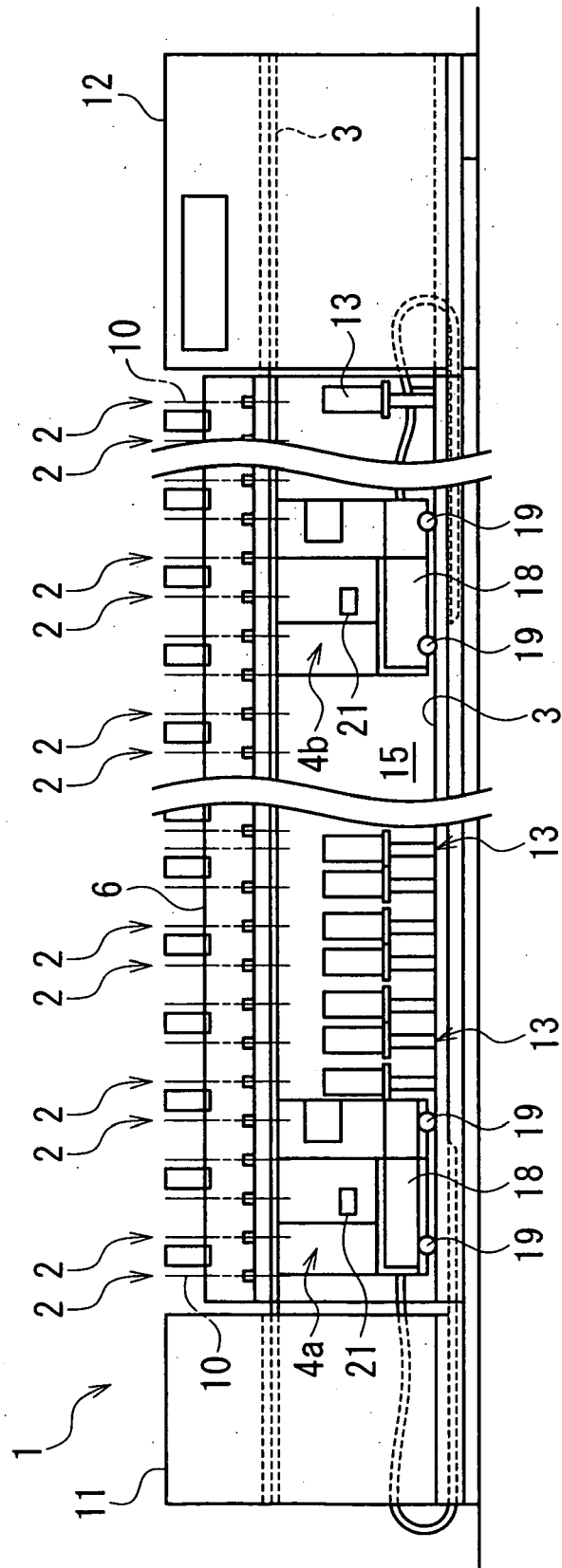


FIGURE 2

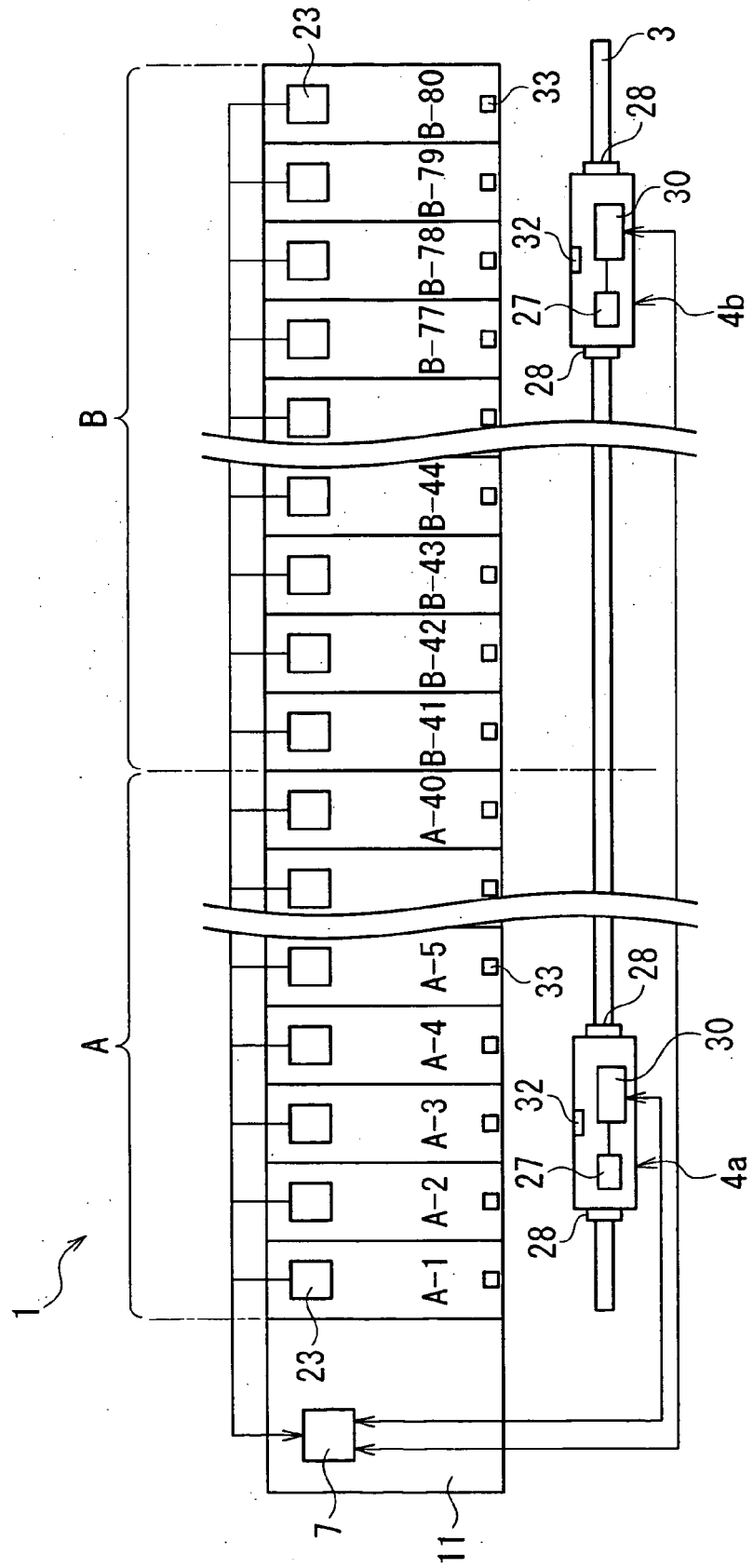


FIGURE 3

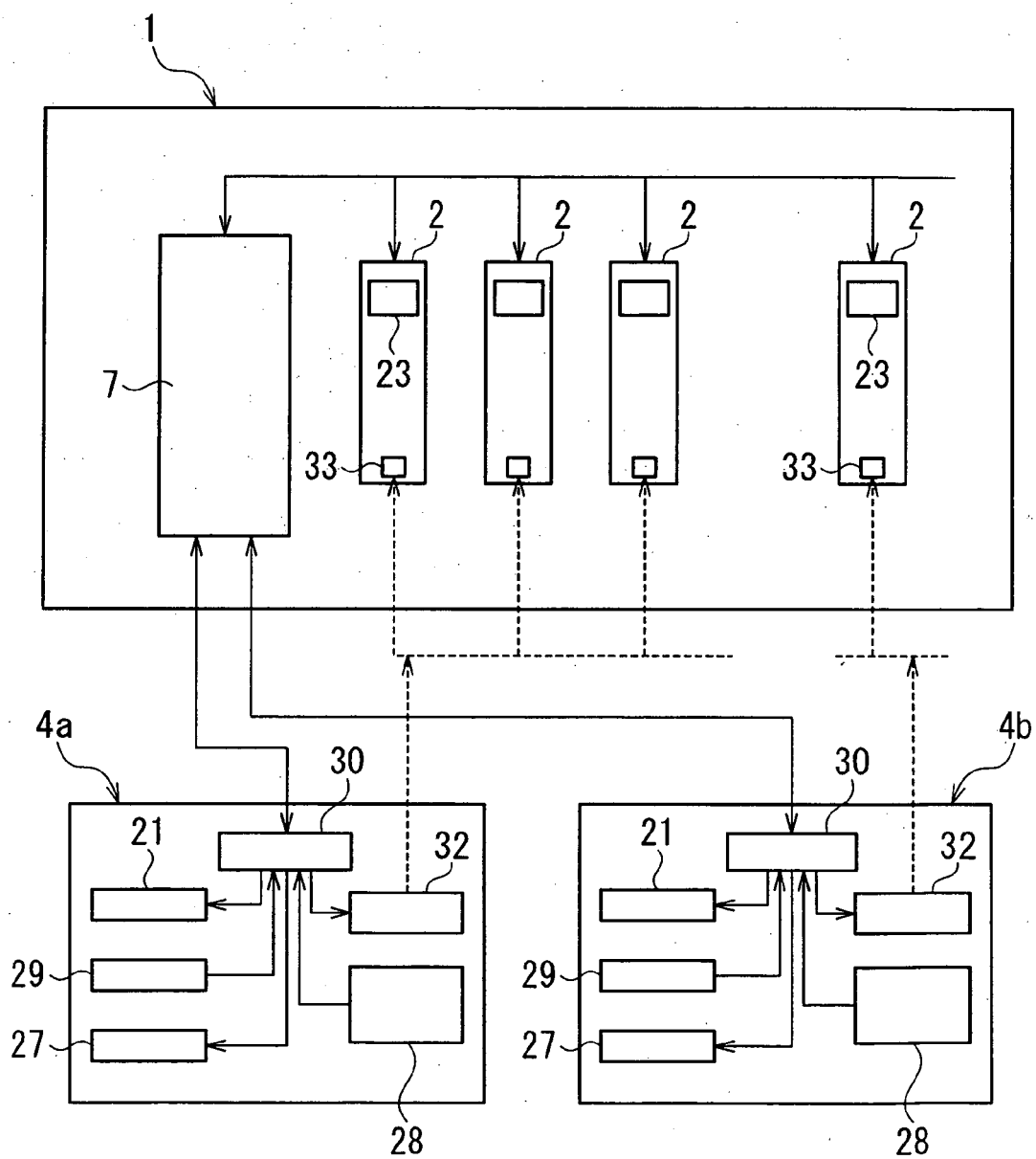


FIGURE 4

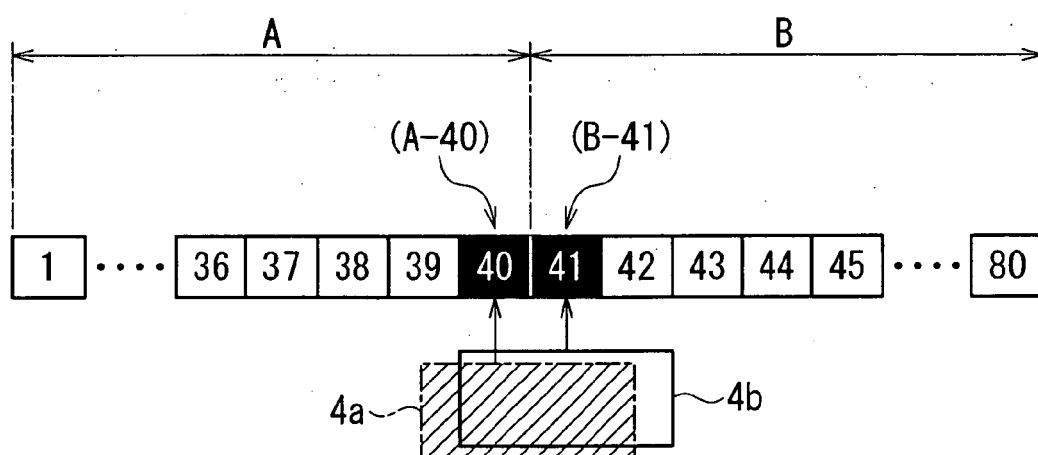


FIGURE 5A

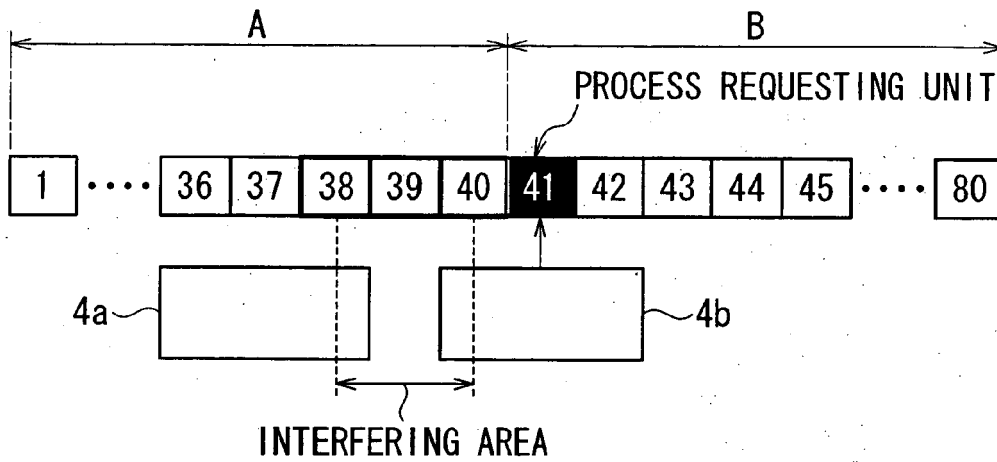


FIGURE 5B

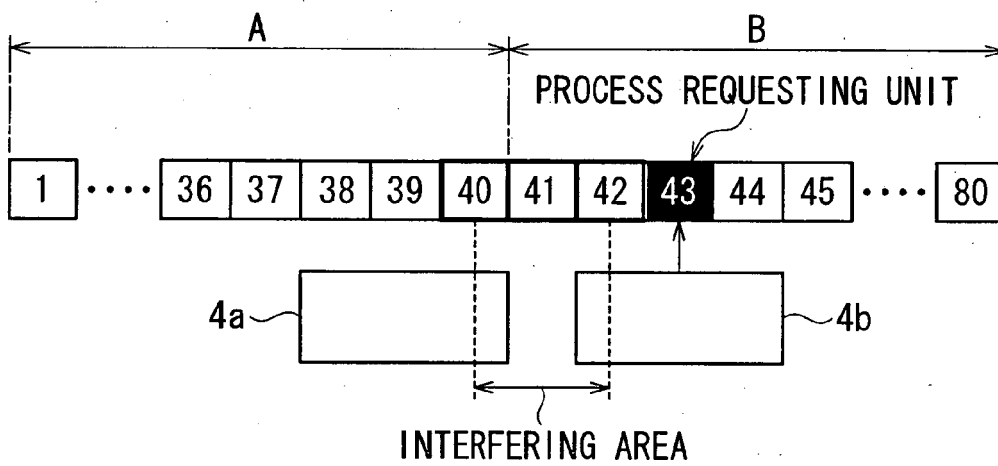


FIGURE 5C

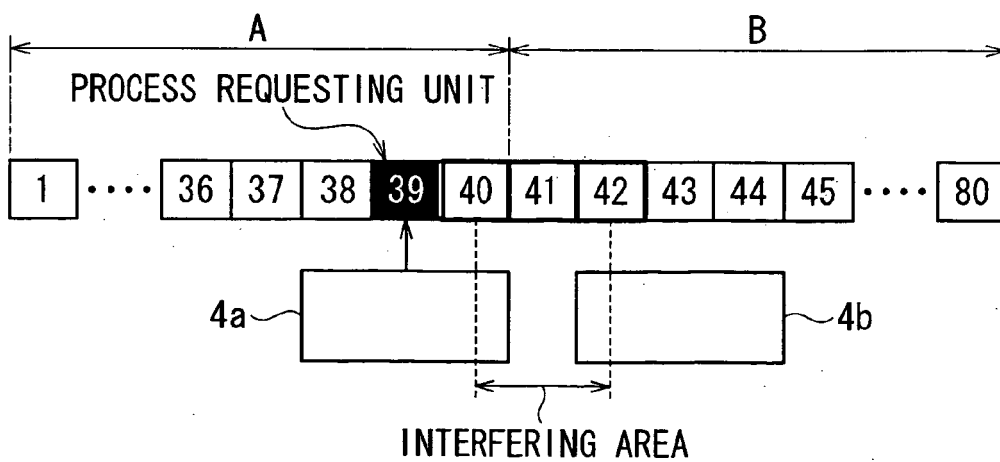
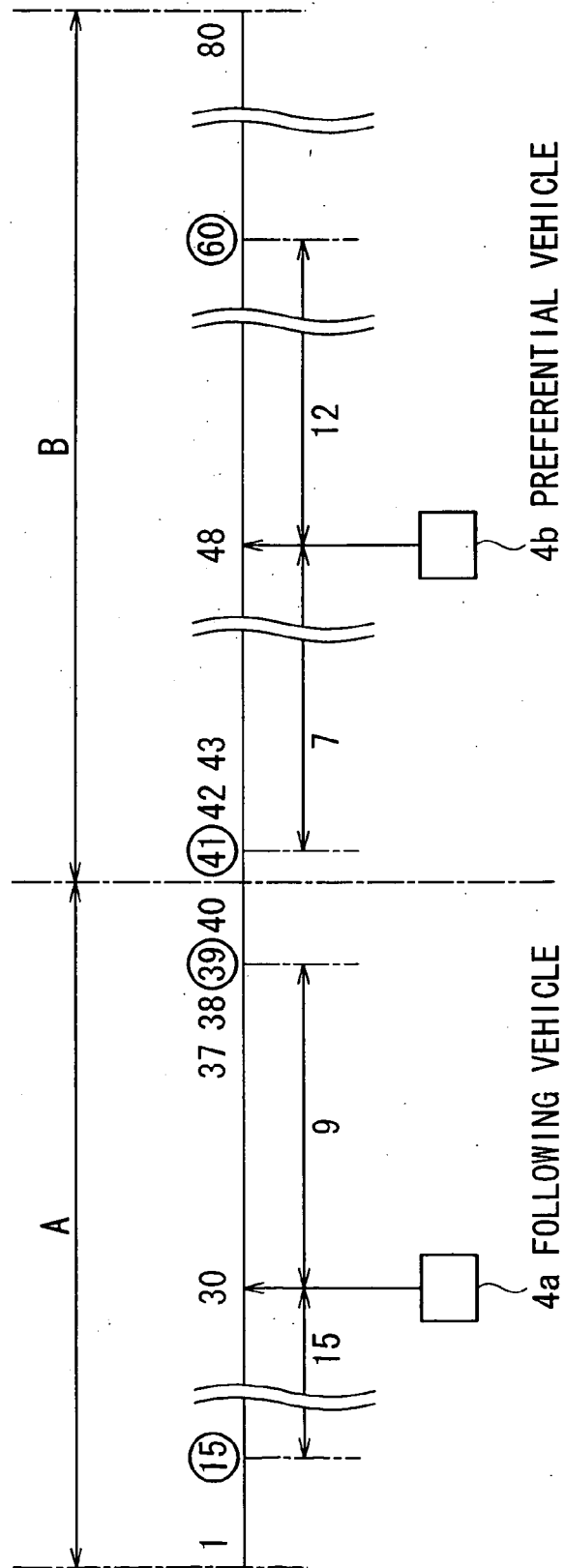


FIGURE 6



REFERENCES CITED IN THE DESCRIPTION

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- JP 6108331 A [0002] [0002] [0004] [0016] [0021]