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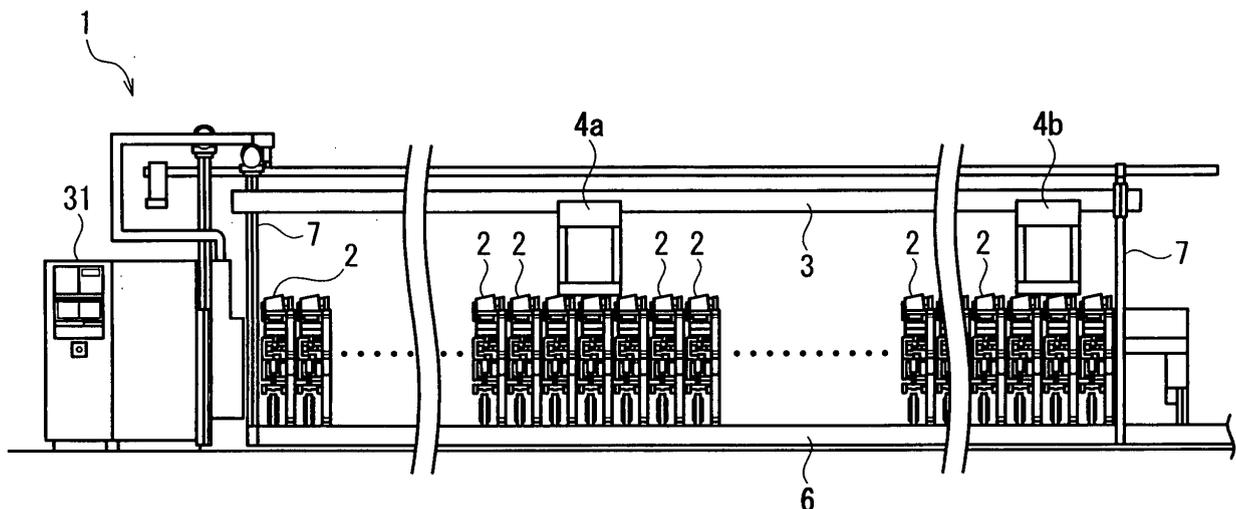
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(54) **Automatic winder and method for controlling doffers in automatic winder**

(57) An object of the present invention is to provide an automatic winder that allows doffers to travel and move efficiently to execute a doffing process with a high work efficiency even if two units located at mutual interference positions issue a request for a doffing process. Traveling of two doffers 4a, 4b is controlled using, as determination criteria, two elements, that is, the progress of full package production in units 2, 2 and the distance from the current position of each of the doffers 4a, 4b to

the corresponding unit 2. Thus, even if two units 2, 2 located at mutual interference positions issue requests for a doffing process, respectively, doffing processes executed on the units 2, 2 by the doffers 4a, 4b can be prioritized before the doffers 4a, 4b are allowed to travel and move with a given distance maintained between them. This makes it possible to reliably prevent disadvantageous, useless traveling of the doffers 4a, 4b; each doffer 4a, 4b can be prevented from stopping or traveling in the reverse direction after approaching the other.

FIGURE 1



Description

Field of the Invention

[0001] The present invention relates to an automatic winder having a plurality of doffers guided and supported so that the doffers can travel freely, on one route provided along a direction in which winding units are arranged, and more specifically, to a technique for preventing a possible operational delay caused by mutual interference between two doffers to improve the work efficiency of doffing operations.

Background of the Invention

[0002] Some textile apparatuses such as automatic winders comprise a plurality of working machines such as doffers or yarn splicing vehicles on one route. A known example of a method for controlling these working vehicles is disclosed in the Unexamined Japanese Patent Application Publication (Tokkai-Hei) No. 6-108331 (hereinafter simply referred to as Japanese Patent Publication).

[0003] The Japanese Patent Publication relates to a method for controlling yarn splicing vehicles in a spinning machine. According to this method, two working vehicles, a yarn splicing vehicle and a roving yarn splicing vehicle, are guided and supported so that the working vehicles can travel freely, on one route. To measure the distance between the working vehicles, an obstacle sensor is installed on each of the working vehicles to preferentially allow the roving yarn splicing vehicle to travel whenever the two working vehicles approach each other. The controlling method described in the Japanese Patent Publication is excellent in the ability to reliably prevent malfunction caused by the possible collision between the two working vehicles.

[0004] However, with the above method, when two units located in proximity to each other issue service process requests, respectively, the working vehicles may travel uselessly. This unavoidably and significantly degrades work efficiency of the working vehicles. The controlling method thus leaves room for improvement in this regard.

[0005] That is, the controlling method in accordance with the Japanese Patent Publication cannot sense that mutual interference is occurring between the working vehicles to preclude the working vehicles from simultaneously performing an operation until the working vehicles approach each other sufficiently to turn the obstacle sensors on. Thus, when two units located in an area where mutual interference is likely to occur issue service process requests, respectively, then in spite of the disability of the two working vehicles to simultaneously perform an operation, each of the working vehicles may travel to the corresponding process requesting unit or may stop or travel in a reverse direction after approaching the other. Consequently, the working vehicles travel uselessly.

Summary of the Invention

[0006] An object of the present invention is to solve the above problems to provide an automatic winder that allows doffers to travel and move efficiently to execute a doffing process with a high work efficiency even if two units located at mutual interference positions issue requests, respectively, for a doffing process.

[0007] The invention set forth in Claim 1 relates to an automatic winder comprising a plurality of winding units each having a winding device that winds a yarn unwound from a supplying device around a winding tube to produce a full package, a route formed along a direction in which the units are arranged, a plurality of doffers configured to be able to travel along the route, and control means for controlling the doffers, the automatic winder automatically executing a doffing process on the units using the doffers.

[0008] A work area comprising a plurality of consecutive units is pre-assigned to each of the doffers, and when any unit belonging to the work area for which the doffer is responsible issues a request for a doffing process, the doffer travels along the route to execute a doffing process on that unit.

[0009] The automatic winder is further characterized in that when two units located in proximity to each other across a boundary between adjacent different work areas issue requests for a doffing process, respectively, traveling of two doffers for the respective units is controlled so that doffing processes executed on the units by the doffers will not cause mutual interference using, as determination criteria, two elements including progress of full package production in the units and a distance from a current position of each of the doffers to the corresponding unit.

[0010] In the invention set forth in Claim 2, an area in which two doffers approaching each other are likely to interfere with each other is defined as an interfering area, and the size of the interfering area is specified on the basis of at least the width dimension of the unit and the width dimension of the doffer in a direction in which the route extends, and each unit checks the progress of full package production and sends the control means at least two types of request signals including a process request signal for a doffing process transmitted after completion of a full package and a pre-request signal transmitted immediately before completion of a full package.

[0011] When two units located in proximity to each other across a boundary between adjacent different work areas issue a process request signal (s) and/or a pre-request signal(s), respectively, resulting in the plurality of process requesting units having issued the request signals, the control means determines, on the basis of the interfering area, whether or not doffing processes executed on the process requesting units by the respective doffers cause mutual interference, and upon determining that mutual interference is likely to occur, the control means can determine the progress of full package pro-

duction on the basis of the request signals, measure the distance from the current position of each of the doffers to the corresponding process requesting unit, and control traveling of the two doffers using the two elements including the progress and the distance as determination criteria.

[0012] Specifically, where the control means determines that mutual interference is likely to occur between the two doffers, when the progress of full package production differs between the two units, a doffing process is preferentially executed on the process requesting unit issuing the process request signal for a doffing process. Where the control means determines that mutual interference is likely to occur between the two doffers, when the progress of full package production is the same between the two units, one of the doffers which is located closer to the corresponding process requesting unit preferentially executes a doffing process on the basis of the measurement result of the distance from the current position of each of the doffers to the corresponding process requesting unit.

[0013] The invention set forth in Claim 3 relates to a method for controlling doffers in an automatic winder comprising a plurality of winding units each having a winding device that winds a yarn unwound from a supplying device around a winding tube to produce a full package, a route formed along a direction in which the units are arranged, a plurality of doffers configured to be able to travel along the route, and control means for controlling the doffers, the automatic winder automatically executing a doffing process on each of the units using the doffers.

[0014] A work area comprising a plurality of consecutive units is pre-assigned to each of the doffers, and when any unit belonging to the work area for which the doffer is responsible issues a request for a doffing process, the doffer travels along the route to execute a doffing process on that unit. An area in which two doffers approaching each other are likely to interfere with each other is defined as an interfering area, and the size of the interfering area is specified on the basis of at least the width dimension of the unit and the width dimension of the doffer in a direction in which the route extends. Each unit checks the progress of full package production and sends the control means at least two types of request signals including a process request signal for a doffing process transmitted after completion of a full package and a pre-request signal transmitted immediately before completion of a full package.

[0015] The method includes a determining step of, when two units located in proximity to each other across a boundary between adjacent different work areas issue a process request signal(s) and/or a pre-request signal(s), respectively, resulting in the plurality of process requesting units having issued the request signals, determining, on the basis of the interfering area, whether or not doffing processes executed on the process requesting units by the respective doffers cause mutual interfer-

ence, a progress checking step of, before or after the determining step, checking and determining the progress of full package production on the basis of the process request signal and/or pre-request signal, and a distance measuring step of, before or after the determining step and the progress checking step, measuring a distance from a current position of each of the doffers to the corresponding process requesting unit.

[0016] Where the determining step determines that mutual interference is likely to occur between the two doffers, when the progress of full package production determined in the progress checking step differs between the two units, a doffing process is preferentially executed on the process requesting unit issuing the process request signal. Where the determining step determines that mutual interference is likely to occur between the two doffers, when the progress of full package production determined in the progress checking step is the same between the two units, one of the doffers which is located closer to the corresponding process requesting unit preferentially executes a doffing process on the basis of the measurement result in the distance measuring step.

[0017] With the automatic winder in accordance with the present invention set forth in Claim 1, when two units located in proximity to each other across a boundary between adjacent different work areas issue doffing process requests, respectively, traveling of the corresponding two doffers is controlled using, as determination criteria, two elements including the progress of full package production in the units and the distance from the current position of each of the doffers to the corresponding unit.

[0018] With the doffers controlled using the two elements, the progress and the distance, as determination criteria as described above, even if two units located at mutual interference positions issue requests for a doffing process, respectively, doffing processes executed on the units by the two doffers can be prioritized in advance on the basis of the two elements (progress and distance) before travelable driving of the doffers to the respective units. This enables the doffers to travel and move efficiently with a given distance maintained between the doffers. This in turn makes it possible to reliably prevent disadvantageous, useless driving of the doffers; each of the doffers can be prevented from stopping or traveling in the reverse direction after approaching the other as is the case with the conventional aspect described in the Japanese Patent Publication. The doffers can thus efficiently execute a doffing process to improve the utilization rate of the winding units, contributing to enhancing the processing ability of the automatic winder.

[0019] According to the invention set forth in Claim 2, the area in which the doffers approaching each other are likely to interfere with each other is defined as an interfering area, and the size of the interfering area is specified on the basis of at least the width dimension of the unit and the width dimension of the doffer in the direction in which the route extends. This makes it possible to reliably determine whether or not the two doffers are likely to

interfere with each other, on the basis of the interfering area. This in turns improves the reliability of traveling control of the doffers.

[0020] In particular, defining the interfering area in terms of the units makes it significantly easier to determine whether or not mutual interference is likely to occur compared to defining the interfering area in terms of a distance dimension (meters or centimeters). This enables determining processes to be reliably executed.

[0021] Definition elements for the interfering area may include not only the width dimensions of the unit and the doffer, described above, but also, for example, the operating distance (designed detection distance) of a collision prevention sensor provided in each doffer. In this case, the possible collision between the doffers can be reliably prevented by setting an interfering area slightly larger than a physical one based on the width dimensions of the unit and the doffer.

[0022] Further, each unit not only transmits a process request signal for a doffing process after completion of a full package but also transmits a pre-request signal immediately before completion of a full package. This enables each of the doffers to move to the processing position of the corresponding unit before a full package is produced. This arrangement makes it possible to reduce the time for which the unit needs to wait after the completion of a full package compared to the arrangement in which the doffer is allowed to travel and move after reception of a process request signal following the completion of a full package. The doffers can thus efficiently execute a doffing process, contributing to enhancing the processing ability of the automatic winder.

[0023] The method for controlling doffers in accordance with the invention set forth in Claim 3 can exert effects similar to those set forth in Claim 1. That is, each of the doffers is controlled using the two elements including the progress and the distance as determination criteria. Consequently, even if two units located at mutual interference positions issue process requests, respectively, processes executed on the units by the respective doffers can be prioritized in advance on the basis of the two elements before the doffers are allowed to travel and move with a given distance maintained between doffers. This makes it possible to reliably prevent disadvantageous, useless driving of the doffers; each of the doffers can be prevented from stopping or traveling in the reverse direction after approaching the other as is the case with the conventional aspect described in the Japanese Patent Publication. The utilization rate of the winding units can thus be improved, contributing to enhancing the processing ability of the automatic winder.

[0024] 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

[0025]

5 Figure 1 is a front view of an automatic winder to which a controlling method in accordance with the present invention is applied.

Figure 2 is a diagram of configuration of a winding unit.

10 Figure 3 is a schematic plan view showing the general configuration of the automatic winder.

Figure 4 is a block diagram showing the electrical configuration of the automatic winder.

15 Figure 5 is a diagram illustrating a mutual interference state.

Figure 6 is a diagram illustrating an interfering area.

Figure 7 is a diagram illustrating a method for controlling doffers.

20 Figure 8 is a diagram illustrating the method for controlling doffers.

Figure 9 is a flowchart illustrating the method for controlling doffers.

Detailed Description of the Preferred Embodiments

25 **[0026]** With reference to the drawings, a description will be given below of an automatic winder and a method for controlling doffers in accordance with the present invention.

30 **[0027]** Figure 1 is a front view of an automatic winder. Figure 2 is a diagram showing the configuration of a winding unit. Figure 3 is a schematic diagram showing the general configuration of the automatic winder. Figure 4 is a block diagram showing the electrical configuration of the automatic winder.

35 **[0028]** The automatic winder 1 is composed of 60 winding units 2 (hereinafter simply referred to as units) called winding units and arranged in a longitudinal direction of a machine base 6, one route 3 formed along a direction in which the units 2 are arranged, doffers 4a, 4b guided and supported so that the doffers 4a, 4b can travel freely, along the route 3, and the like. In the present embodiment, the direction in which the units 2 are arranged is defined as a lateral direction, and the position at which the route 3 is disposed as viewed from the units 2 is defined as a front position.

40 **[0029]** As shown in Figure 2, each of the units 2 is equipment having a winding device 12 disposed at the top to wind a yarn 11 unwound from a supplying bobbin 10 around a winding tube 13 to produce a full package 14. Various devices are disposed in each unit 2, including a supplying device 15 having a unwinding assisting device, a tension device 16, a yarn splicing device 17, a slab catcher 18, and the winding device 12 having a traversing drum 19: the devices are located in this order from the bottom of the unit along the path of a yarn 11. The devices are controlled on the basis of control signals from a control device 20 provided in each unit 2. As shown

in Figure 1, a driving box 31 containing a central control device 30 (see Figure 3) and the like is provided at one lateral end of the machine base 6. A bobbin preparing device (not shown in the drawings) is provided at the other lateral end to supply supplying bobbins 10 to the supplying devices 15.

[0030] As shown in Figure 2, the winding device 12 is composed of the traversing drum 19 that traverses the yarn 11 while rotationally driving the package, a driving motor 21 that rotates the traversing drum 19, an inverter 22 that controls the rotation speed of the driving motor 21, and the like. The winding device 12 rotates the traversing drum 19 at the optimum rotation speed for the winding status of each unit 2 on the basis of control signals from the control device 20.

[0031] The winding device 12 comprises a winding amount detecting function for measuring the amount of yarn 11 wound around the winding tube 13. Specifically, the winding device 12 comprises a pulse generating device that detects the rotation number of the traversing drum 19, which supplies the yarn 11 to the winding tube 13. The control device 20 can thus calculate the length of the yarn wound around the winding tube 13, that is, the winding amount, on the basis of a pulse count sent by the pulse generating device.

[0032] The control device 20 checks the progress of production of a full package 14 on the basis of the winding amount obtained, and reports the progress to the central control device 30 and control devices (control means) 41 for the doffers 4a, 4b. Specifically, the control device 20 compares the winding amount obtained with a preset winding amount required to obtain a full package 14. Upon determining that a full package 14 has been completed, the control device 20 transmits a process request signal for a doffing process to the central control device 30 and the control devices 41. Immediately before the completion of a full package 14, the control device 20 also transmits a pre-request signal indicating that a full package 14 will be completed soon, to the central control device 30 and the control devices 41.

[0033] More specifically, a memory 23 (see Figure 2) contained in the control device 20 stores a first threshold corresponding to a yarn length required to complete a full package 14 and a second threshold slightly smaller than the first threshold. When the winding amount calculated on the basis of the pulse count sent by the pulse generating device exceeds the second threshold, a pre-request signal is transmitted. When the winding amount exceeds the first threshold, the rotation of the traversing drum 19 is halted to stop the operation of winding the yarn 11. Further, a process request signal for a doffing process is transmitted.

[0034] The simple phrase "request signal" in the description below includes both the process request signal, transmitted after the completion of a full package, and the pre-request signal.

[0035] As shown in Figure 1, a lateral pair of frames 7, 7 is disposed upright at the laterally opposite ends of

the machine base 6, and a route 3 is disposed between the frames 7, 7. Two doffers 4a, 4b are guided and supported on the route 3 so that the doffers 4a, 4b can travel freely in the lateral direction. Each of the doffers 4a, 4b performs an operation of unloading the full package 14, an operation of setting the winding tube 13 in the winding device 12, an operation of picking up a yarn end, and the like. Each of the doffers 4a, 4b contains in its rectangular box-like housing a processing device 44 that executes an appropriate processing operation, travel driving wheels, a motor 43 (see Figures 3 and 4) that drives the driving wheels, and the like.

[0036] When any unit 2 produces a full package 14 and transmits a doffing process request signal, the corresponding one of the doffers 4a, 4b drives the travel driving wheels via the motor 43 to travel and stop above the unit 2 having transmitted the process request signal, in accordance with a control signal from the control device 20. The processing device 44 is driven to unload the full package 14 and then to set the winding tube 13 in the winding device 12 (doffing process).

[0037] As shown in Figure 3, collision prevention sensors 40, 40 are provided at the laterally opposite ends of each of the doffers 4a, 4b. Both doffers 4a, 4b make an emergency stop when, for example, the distance between the doffers 4a, 4b measured by the sensors 40, 40 decreases below a predetermined value (set detection distance). In Figure 3, a reference numeral 41 is a control device that controls each of the doffers 4a, 4b. In Figure 4, a reference numeral 42 is a dog sensor that senses a dog (not shown in the drawings) provided on each unit 2.

[0038] As shown in Figure 3, unit numbers 1, 2, ..., 59, 60 are sequentially assigned to the 60 units 2, arranged in the lateral direction, starting with the unit 2 located at one end (left end) of the base of the automatic winder 1.

[0039] A first doffer 4a located closer to the left end of the route 3 (hereinafter appropriately referred to as the first doffer) is responsible for executing a doffing process on the units 2 with unit numbers 1 to 30. A second doffer 4b located closer to the right end of the route 3 (hereinafter appropriately referred to as the second doffer) is responsible for executing a doffing process on the units 2 with unit numbers 31 to 60.

[0040] In other words, a work area A composed of the 30 units 2 with unit numbers 1 to 30 is pre-assigned to the first doffer 4a. A work area B composed of the 30 units 2 with unit numbers 31 to 60 is pre-assigned to the second doffer 4b. Each of the doffers 4a, 4b travels and moves within the route 3 to execute a doffing process on the units 2 belonging to the work area A, B of the doffer 4a, 4b.

[0041] In the description below, the units 2 with unit numbers 1 to 30 which belong to the work area A and on which the first doffer 4a executes a doffing process are appropriately referred to as units (A-1) to (A-30). The units 2 with unit numbers 31 to 60 which belong to the work area B and on which the second doffer 4b executes a doffing process are appropriately referred to as units (B-

31) to (B-60).

[0042] The unit numbers of the units 2 are stored in the control device 20 (see Figure 3). The unit number is contained in the pre-request signal and process request signal, transmitted by the unit 2 to the central control device 30 and the control devices 41 for the doffers 4a, 4b. On the basis of the unit number information, the central control device 30 and the control devices 41 for the doffers 4a, 4b can determine which of the units 2 is issuing a process request.

[0043] A position detecting function section is provided between the doffers 4a, 4b and the units 2 to sense the current positions of the doffers 4a, 4b. The position detecting function section in accordance with the present embodiment is composed of signal output sections 32 each comprising a coil that outputs a magnetic signal to the appropriate unit 2 and signal receiving sections 33 each comprising a reception element that receives signals from the signal output section 32.

[0044] When the doffer 4a, 4b arrives and stops above the target unit 2, the control device 41 for the doffers 4a, 4b drives the signal output section 32 to output an instruction signal to the unit 2 which instructs the unit 2 to respond with the 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 41 for the doffers 4a, 4b via the central control device 30. The stopped doffers 4a, 4b can determine which of the units 2 it is stopped above, on the basis of the response signal. That is, the doffers 4a, 4b can obtain information on its own current position. After starting traveling, the doffers 4a, 4b count the number of dogs sensed by the dog sensor 42 on the basis of the current position information. The doffers 4a, 4b thus calculate the number of units 2 by which it has passed during traveling to determine the distance from the stop position to determine the current position during traveling. Upon determining that it has arrived in front of the target unit 2, the doffers 4a, 4b stop driving the motor 43 to halt and transmits a signal to the signal receiving section 33 of the unit 2. Then, in response to this signal, the unit 2 returns a response signal, on the basis of which the doffers 4a, 4b check its own current position. The series of position checking operations enables the doffers 4a, 4b to accurately determine its own current position.

[0045] As shown in Figures 1 and 3, the units 2 are consecutively arranged without any distance between them. Each doffer 4a, 4b has a larger lateral width dimension than that of each unit 2. Thus, when attempting to simultaneously execute a doffing operation on the respective units 2, 2 located in proximity to each other across the boundary between the work areas A, B, the two doffers 4a, 4b may interfere with each other and fail to execute a doffing process (this is hereinafter referred to as a mutual interference state).

[0046] For example, as shown in Figure 5, even when the unit 2 A-30 located at the right end of the work area

A and the unit 2 B-31 located at the left end of the work area B issue doffing process requests, respectively, it is physically impossible to arrange the doffers 4a, 4b above these two units (A-30, B-31) because of the mutual interference between the doffers 4a, 4b. This precludes the doffers 4a, 4b from simultaneously executing a doffing process on the units (A-30, B-31).

[0047] To determine whether or not such mutual interference is likely to occur, the automatic winder 1 has an interfering area where the two doffers 4a, 4b approaching each other are likely to interfere with each other. The size of the interfering area can be optionally defined on the basis of the following dimensions in the direction of extension of the route: the width dimension of the unit 2, the width dimension of the doffers 4a, 4b, and the set detection distance for the collision prevention sensor 40, provided in each doffer 4a, 4b. In the present embodiment, the units within three ranges based on the process requesting unit 2 are defined as an interfering area.

[0048] Specifically, as shown in Figure 6A, when the second doffer 4b is located in front of the unit (B-31), the first doffer 4a cannot be located in front of the unit (A-28), the unit (A-29) or unit (A-30). Consequently, when the unit (B-31) issues a process request, the control devices 41, 41 for the doffers 4a, 4b define the units (A-28), (A-29) and (A-30) as an interfering area.

[0049] Similarly, as shown in Figure 6B, when the unit (B-33) issues a process request, the control device 41 for the first doffer 4a defines the units (A-30), (B-31) and (B-32) as an interfering area. Further, in view of the work area A, for which the first doffer 4a is responsible for executing a doffing process, substantially only the unit (A-30) corresponds to the interfering area.

[0050] As shown in Figure 6C, when the unit (A-29) issues a process request, the control device 41 for the second doffer 4b defines the units (A-30), (B-31) and (B-32) as an interfering area. In view of the work area B, for which the second doffer 4b is responsible for executing a doffing process, substantially the units (B-31) and (B-32) correspond to the interfering area.

[0051] Now, with reference to Figures 7, 8, and 9, a description will be given of a specific method for controlling the doffers 4a, 4b in the automatic winder 1 configured as described above.

[0052] It is assumed that as shown in Figures 7 and 8, the unit (A-29) issues a doffing process request signal and that the first doffer 4a is moving above the unit (A-20) from left to right toward the unit (A-29). It is also assumed that the second doffer 4b is waiting above the unit (B-38). It is further assumed that at this time, the unit (B-31) transmits a request signal to the second doffer 4b.

[0053] Specifically, Figure 7 shows that the unit (B-31) transmits a request signal for a doffing process, and that the units (A-29) and (B-31) transmit request signals with the same progress. On the other hand, Figure 8 shows that the unit (B-31) transmits a pre-request signal, and that the units (A-29) and (B-31) transmit request signals with different progresses.

[0054] Upon receiving the request signals from the units (A-29) and (B-31), the control devices 41 for the doffers 4a, 4b determine whether or not the process requesting units (A-29) and (B-31) are in a positional relationship to bring a mutual interference state, on the basis of the interfering area (determining step, S1: Figure 9). The control devices 41 further measure the distances to the process requesting units (A-29) and (B-31) (distance measuring step, S2).

[0055] The situation shown in Figures 7 and 8 may bring a mutual interference state. This is because the process requesting unit (B-31) for the second doffer 4b is located in the interfering area based on the process requesting unit (A-29) for the first doffer 4a, while the process requesting unit (A-29) for the first doffer 4a is located in the interfering area based on the process requesting unit (B-31) for the second doffer 4b. Consequently, even when the doffer 4a is moved to the unit (A-29), while the doffer 4b is moved to the (B-31), it is physically impossible to simultaneously execute doffing processes on the units (A-29) and (B-31), respectively (see Figures 6A and 6C). The determining step (S1) determines that the mutual interference state has been established (Yes in S1).

[0056] Where the determining step (S1) determines that the mutual interference state has not been established (No in S1), the doffers 4a, 4b execute a doffing process on the respective units 2, 2 (S7).

[0057] Thus, when the determining step determines that the mutual interference state has been established (Yes in S1), the control devices 41 for the doffers 4a, 4b check and determine the progress of full package production on the basis of request signals from the process requesting units (A-29) and (B-31) (progress checking step, S3). When the progress differs between the request signals (No in S3), a doffing process is preferentially executed on the process requesting unit issuing a process request signal after the completion of a full package (S8, S6). When the progress is the same between the request signals (Yes in S3), any one of the doffers 4a, 4b located closer to the corresponding process requesting unit preferentially executes a doffing process (S4, S5, S6).

[0058] Specifically, as shown in Figure 7, where both units (A-29) and (B-31) transmit a process request signal after completing production of a full package 14, the progress of full package production is the same between the units 2, 2 (Yes in S3). This prevents doffing processes executed on the units 2 by the doffers 4a, 4b, from being prioritized on the basis of the progress. Thus, operations performed by the doffers 4a, 4b are prioritized on the basis of the distance from the doffers 4a, 4b to the corresponding process requesting units 2 (S4, S5).

[0059] In the aspect shown in Figure 7, the distance from the current position (A-20) of the first doffer 4a to the process requesting unit (A-29) is equal to 9 units. The distance from the current position (B-38) of the second doffer 4b to the process requesting unit (B-31) is equal to 7 units. The second doffer 4b is determined to be a

preferential doffer, while the first doffer 4a is determined to be a following doffer (S5). The second doffer 4b, the preferential doffer, is allowed to travel and move to above the process requesting unit (B-31). A doffing process is then preferentially executed on the unit (B-31) (S6).

[0060] On the other hand, as shown in Figure 8, where the unit (A-29) transmits a process request signal for doffing after completing production of a full package 14 and the unit (B-31) transmits a pre-request signal, the progress differs between the units 2, 2 (No in S3). The first doffer 4a preferentially executes a doffing process on the unit (A-29). In this case, in contrast to the case shown in Figure 7, the first doffer 4a is determined to be the preferential doffer, while the second doffer 4b is determined to be the following doffer 4b.

[0061] Thus, once the preferential doffer is determined and the process requesting unit 2 on which a doffing process is preferentially executed is determined, the control device 41 for the following doffer determines the unit(s) 2 that is to be disabled on the basis of the interfering area, and masks the process request signal (s) from the unit(s) 2 (S6). The term "mask" as used herein means exclusion, disregard, hiding and the like.

[0062] In the state in Figure 7, on the basis of the unit (B-31) to be preferentially processed, the units (A-28), (A-29) and (A-30) are determined to belong to the interfering area (see Figure 6A) and the process request signals from these three units are masked. Then, the unit 2 other than the above three on which the first doffer 4a can execute a doffing process is limitedly determined. That is, since the process requesting unit (A-29) is one of the masked units 2, the first doffer 4a, the following doffer, postpones the doffing process on the process requesting unit (A-29) and executes a doffing process on another unit 2.

[0063] Further, in the state in Figure 7, when no other process request signal or pre-process request signal has been issued, the first doffer 4a travels and moves toward the processing target unit (A-29). The first doffer 4a then waits away from the area where the first doffer 4a and the second doffer 4b may interfere with each other but as close as possible to the unit (A-29). In Figure 7, the interfering area based on the unit (B-31) is located above the units (A-28) to (A-30). Accordingly, the first doffer 4a waits above the unit (A-27) (see Figure 6A). Then, once the second doffer 4b finishes a doffing process on the unit (B-31), it immediately leaves the interfering area (see Figure 6C) based on the unit (A-29), the process requesting unit, and moves to another unit for a doffing process. During the leaving action, the first doffer 4a moves to above the unit (A-29) to execute a doffing process.

[0064] When the determining step (S1) determines that the mutual interference state has not been established (No in S1), each doffer 4a, 4b moves to above the corresponding process requesting unit for doffing.

[0065] As described above, the automatic winder in accordance with the present embodiment controls traveling of the doffers 4a, 4b on the basis of the two

elements, that is, the progress of full package production in the units 2, 2 and the distance from the current position of each doffer 4a, 4b to the corresponding unit 2. Thus, even if two units 2, 2 located at mutual interference positions issue requests for a doffing process, respectively, doffing processes executed on the units 2, 2 by the doffers 4a, 4b can be prioritized in advance on the basis of two elements (progress and distance) before the doffers 4a, 4b are driven to travel to the respective units 2, 2. This enables the doffers 4a, 4b to travel and move efficiently with a given distance maintained between them.

[0066] This makes it possible to reliably prevent disadvantageous, useless traveling of the doffers 4a, 4b; each doffer 4a, 4b can be prevented from stopping or traveling in the reverse direction after approaching the other. The doffers 4a, 4b can thus efficiently execute a doffing process to improve the utilization rate of the winding units 2, contributing to enhancing the processing ability of the automatic winder 1.

[0067] When the size of the area where the two doffers 4a, 4b approaching each other are likely to interfere with each other is predefined as an interfering area, it is possible to reliably possible to determine on the basis of the interfering area, whether or not the doffers 4a, 4b are likely to enter a mutual interference state. This improves reliability in the traveling control of the doffers 4a, 4b. In particular, defining the interfering area in terms of the units 2 makes it significantly easier to determine whether or not the mutual interference state is likely to occur compared to defining the interfering area in terms of a distance dimension (meters or centimeters). This enables determining processes to be reliably executed.

[0068] Further, each unit 2 not only transmits a process request signal for a doffing process after completion of a full package 14 but also transmits a pre-request signal immediately before completion of a full package 14. This enables each of the doffers 4a, 4b to move to the processing position of the corresponding unit 2 before a full package 14 is produced. This arrangement makes it possible to reduce the time for which the unit 2 needs to wait after the completion of a full package 14 compared to the arrangement in which the doffers 4a, 4b are allowed to travel and move after reception of a process request signal following the completion of a full package 14. The doffers 4a, 4b can thus efficiently execute a doffing process, contributing to enhancing the processing ability of the automatic winder 1.

[0069] In the above embodiment, the three units 2 preceding or following the process requesting unit 2 are defined as an interfering area. However, the present invention is not limited to this. Four or more consecutive units preceding or following the process requesting unit 2 may be defined as an interfering area, or one unit adjacent to the process requesting unit 2 in either direction may be defined as an interfering area. This is because the interfering area is defined in accordance with the lateral width dimensions of the unit 2 and the doffer 4a, 4b, the sensitivity of the collision prevention sensor 40, and the like.

[0070] The number of winding units 2 provided in the automatic winder 1 is not limited to 60. The number may be larger or smaller than 60. Similarly, the number of doffers supported so that they can travel freely on the route 3 is not limited provided that the number is at least 2.

[0071] The position detecting function section sensing the current positions of doffers 4a, 4b is not limited to the one composed of magnetic elements and reception elements as described above. For example, the position detecting function section may transmit and receive signals, for example, through radio communication.

[0072] The above embodiment has been described in conjunction with the control method using only the two elements, the progress and distance, as determination criteria. However, the above control method is illustrative and the present invention is not limited to it. That is, in addition to the progress and the distance, detection signals from the collision prevention sensors can also be used as an element to control traveling of the doffers. Specifically, for example, the following control method can be employed: upon receiving a detection signal from the collision prevention sensor 40 while traveling to a process requesting unit 2, the preferential doffer continues to travel to the process requesting unit 2 while reducing its traveling speed.

[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. An automatic winder comprising a plurality of winding units each having a winding device that winds a yarn unwound from a supplying device around a winding tube to produce a full package, a route formed along a direction in which the units are arranged, a plurality of doffers configured to be able to travel along the route, and control means for controlling the doffers, the automatic winder automatically executing a doffing process on the units using the doffers, the automatic winder being **characterized in that:**

a work area comprising a plurality of consecutive units is pre-assigned to each of the doffers, and when any unit belonging to the work area for which the doffer is responsible issues a request for a doffing process, the doffer travels along the route to execute a doffing process on the unit, when two units located in proximity to each other across a boundary between adjacent different work areas issue requests for a doffing process,

respectively, traveling of two doffers for the respective units is controlled so that doffing processes executed on the units by the doffers will not cause mutual interference using, as determination criteria, two elements including progress of full package production in the units and a distance from a current position of each of the doffers to the corresponding unit.

2. The automatic winder according to Claim 1, **characterized in that:**

an area in which two doffers approaching each other are likely to interfere with each other is defined as an interfering area, and the size of the interfering area is specified on the basis of at least the width dimension of the unit and the width dimension of the doffer in a direction in which the route extends,
 each unit checks the progress of full package production and sends the control means at least two types of request signals including a process request signal for a doffing process transmitted after completion of a full package and a pre-request signal transmitted immediately before completion of a full package, and
 when two units located in proximity to each other across a boundary between adjacent different work areas issue a process request signal and/or a pre-request signal, resulting in the plurality of process requesting units having issued the request signals, the control means determines, on the basis of said interfering area, whether or not doffing processes executed on the process requesting units by the respective doffers cause mutual interference, and upon determining that mutual interference is likely to occur, the control means determines the progress of full package production on the basis of the request signals, measures the distance from the current position of each of the doffers to the corresponding process requesting unit, and controls traveling of the two doffers using the two elements including the progress and the distance.

3. A method for controlling doffers in an automatic winder comprising a plurality of winding units each having a winding device that winds a yarn unwound from a supplying device around a winding tube to produce a full package, a route formed along a direction in which the units are arranged, a plurality of doffers configured to be able to travel along the route, and control means for controlling the doffers, the automatic winder automatically executing a doffing process on the units using the doffers, the method being **characterized in that:**

a work area comprising a plurality of consecutive units is pre-assigned to each of the doffers, and when any unit belonging to the work area for which the doffer is responsible issues a request for a doffing process, the doffer travels along the route to execute a doffing process on that unit , an area in which two doffers approaching each other are likely to interfere with each other is defined as an interfering area, and the size of the interfering area is specified on the basis of at least the width dimension of the unit and the width dimension of the doffer in a direction in which the route extends,
 each unit checks the progress of full package production and sends the control means at least two types of request signals including a process request signal for a doffing process transmitted after completion of a full package and a pre-request signal transmitted immediately before completion of a full package,
 the method includes a determining step of, when two units located in proximity to each other across a boundary between adjacent different work areas issue a process request signal and/or a pre-request signal, resulting in the plurality of process requesting units having issued the request signals, determining, on the basis of said interfering area, whether or not doffing processes executed on the process requesting units by the respective doffers cause mutual interference;
 a progress checking step of, before or after said determining step, checking and determining the progress of full package production on the basis of said process request signal and/or pre-request signal; and
 a distance measuring step of, before or after said determining step and progress checking step, measuring a distance from a current position of each of the doffers to the corresponding process requesting unit,
 where said determining step determines that mutual interference is likely to occur between the two doffers, when the progress of full package production determined in said progress checking step differs between the two units, a doffing process is preferentially executed on the process requesting unit issuing the process request signal, and
 where said determining step determines that mutual interference is likely to occur between the two doffers, when the progress of full package production determined in said progress checking step is the same between the two units, one of the doffers which is located closer to the corresponding process requesting unit preferentially executes a doffing process on the basis of the measurement result in said distance measuring step.

FIGURE 1

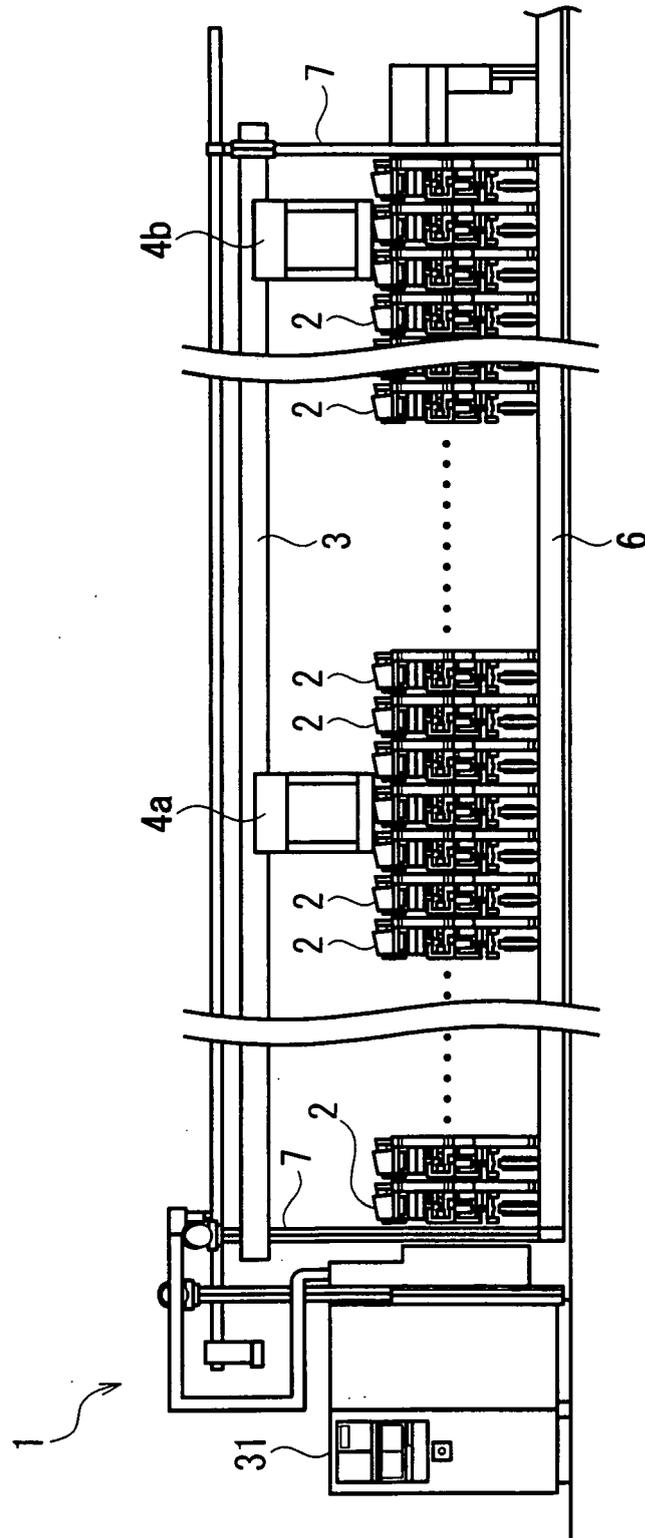


FIGURE 2

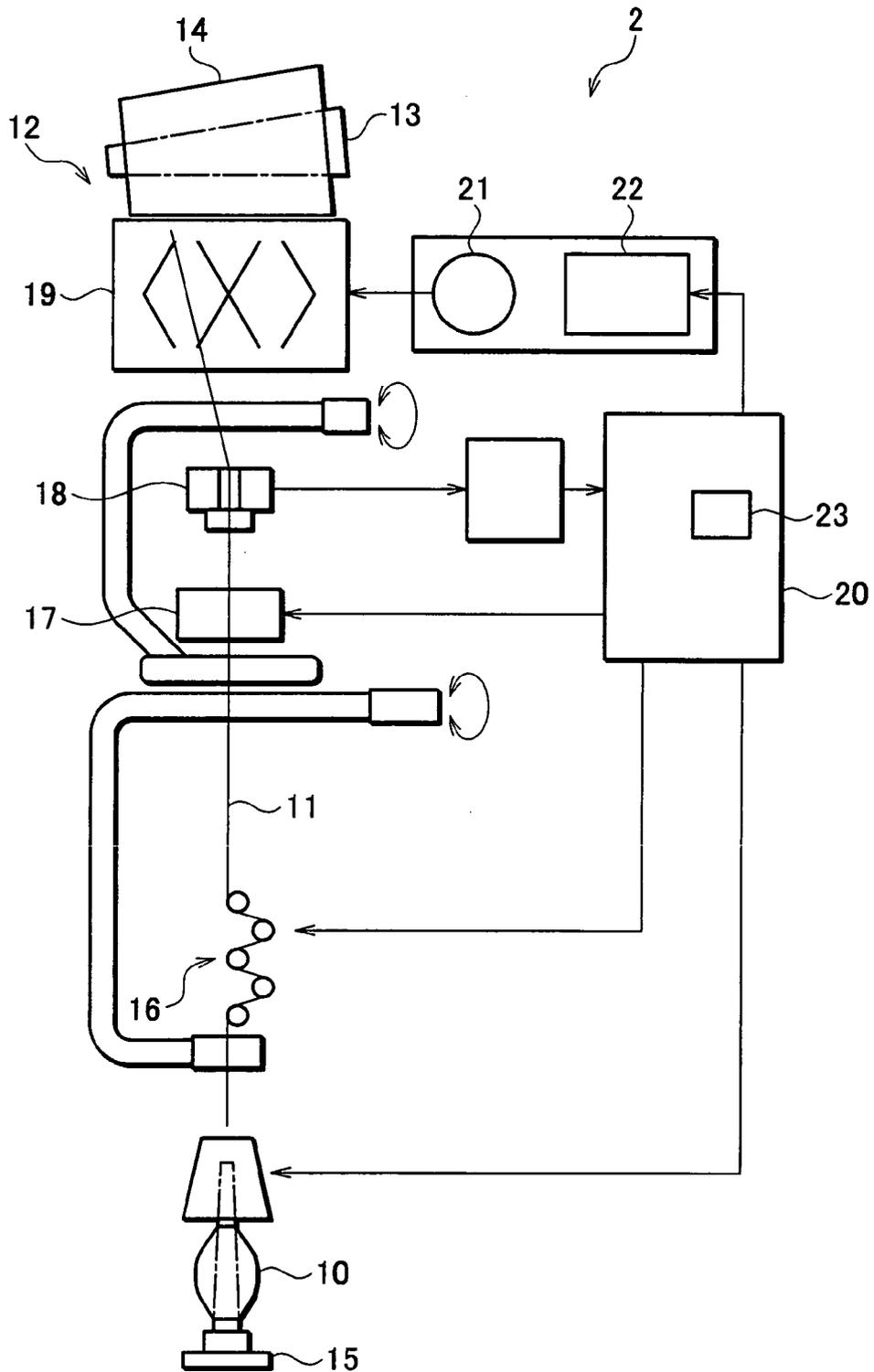


FIGURE 3

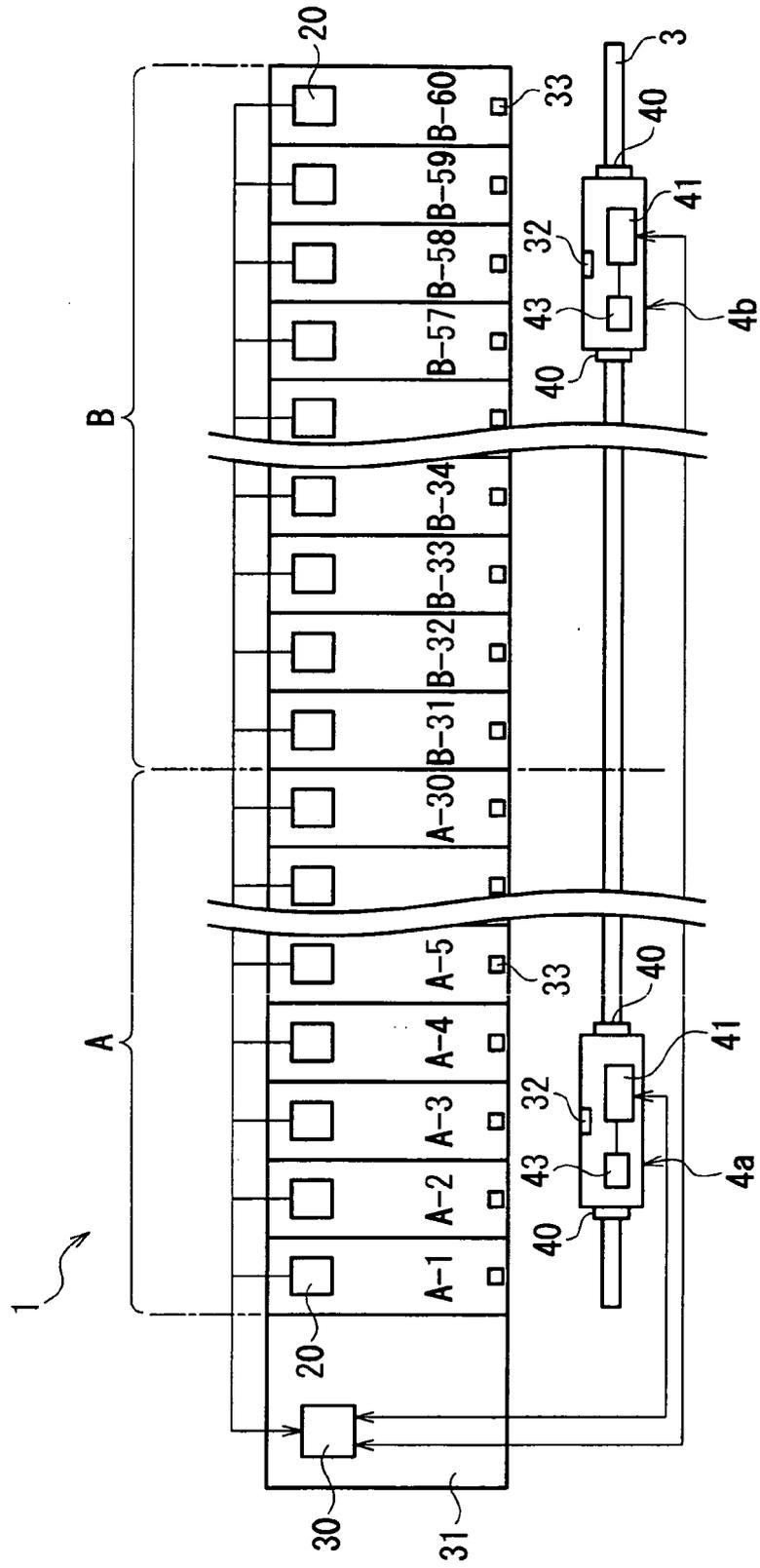


FIGURE 4

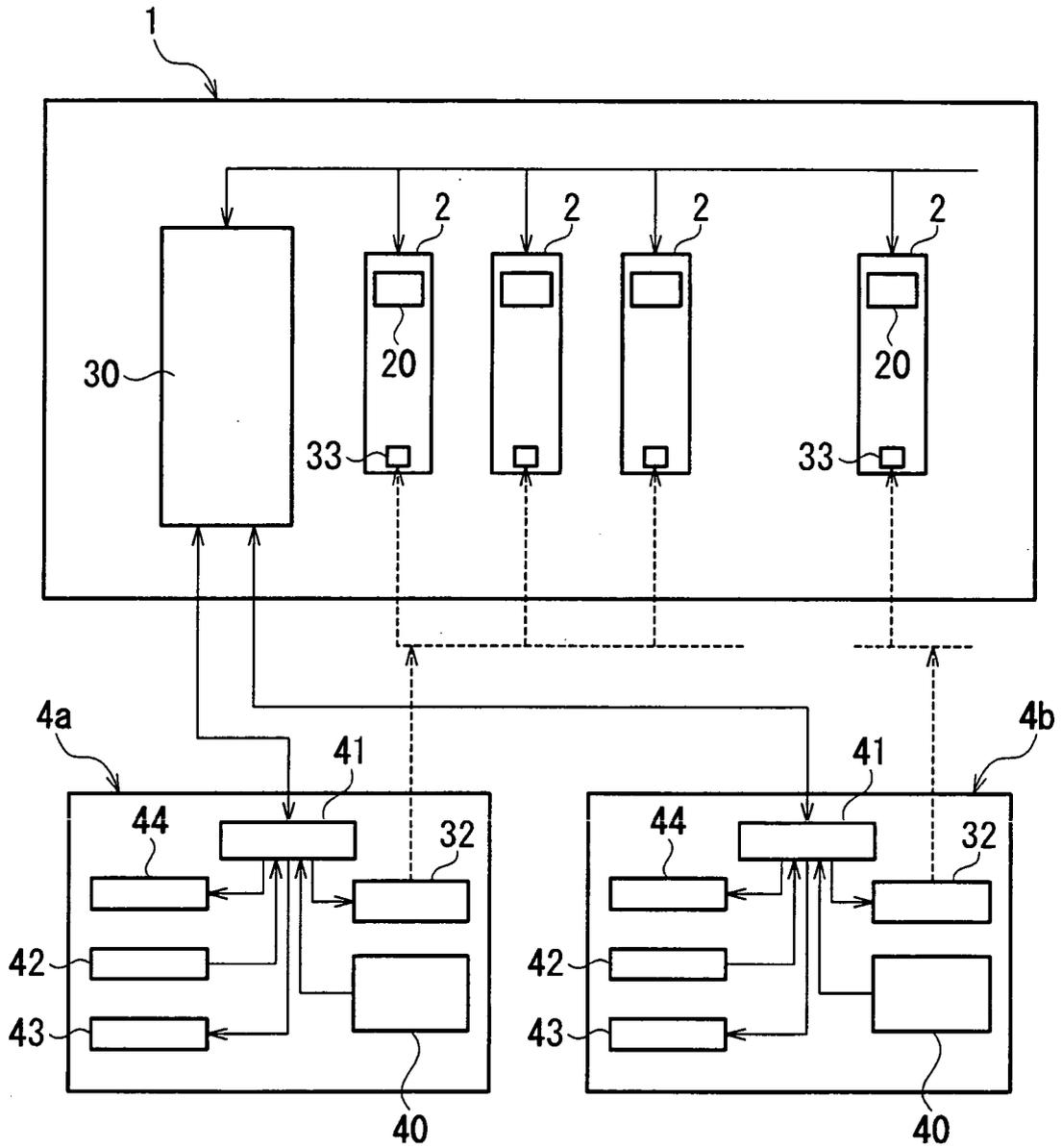


FIGURE 5

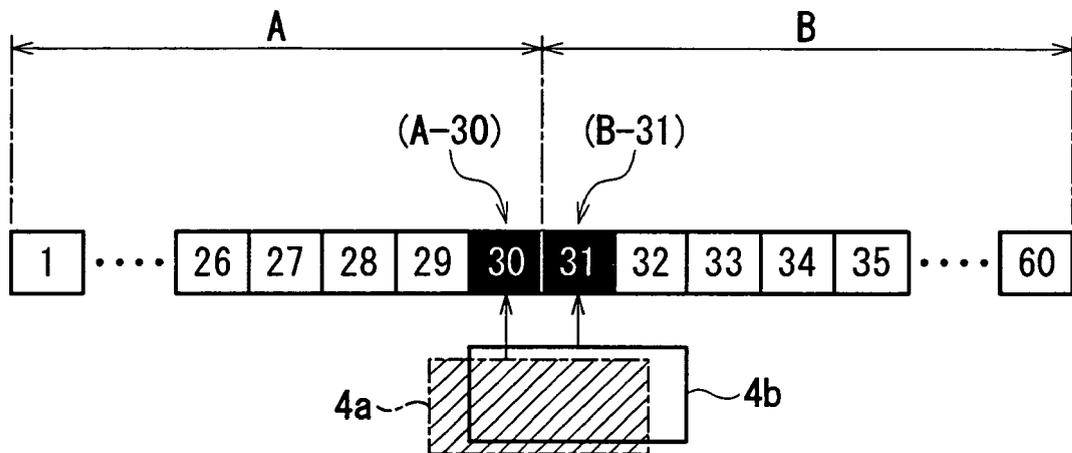


FIGURE 6A

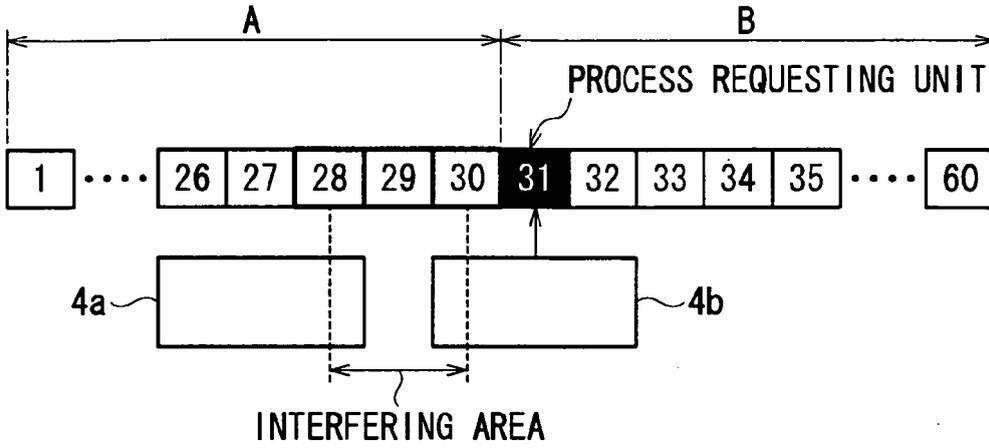


FIGURE 6B

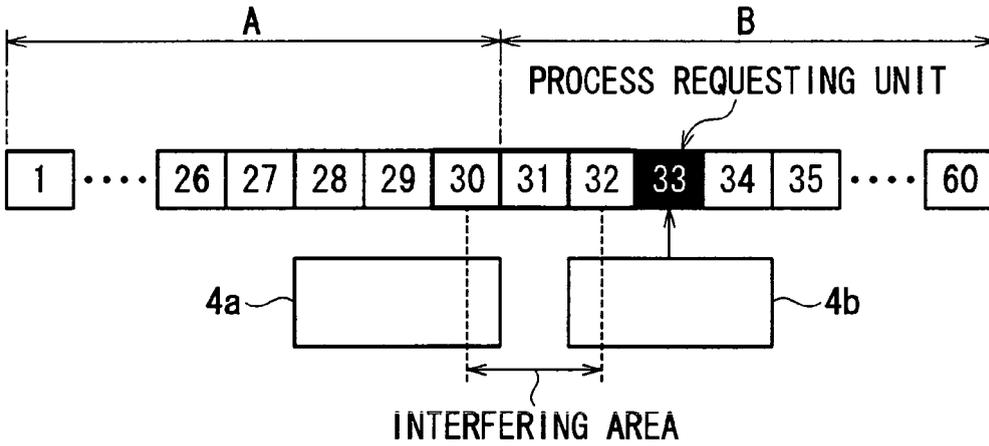


FIGURE 6C

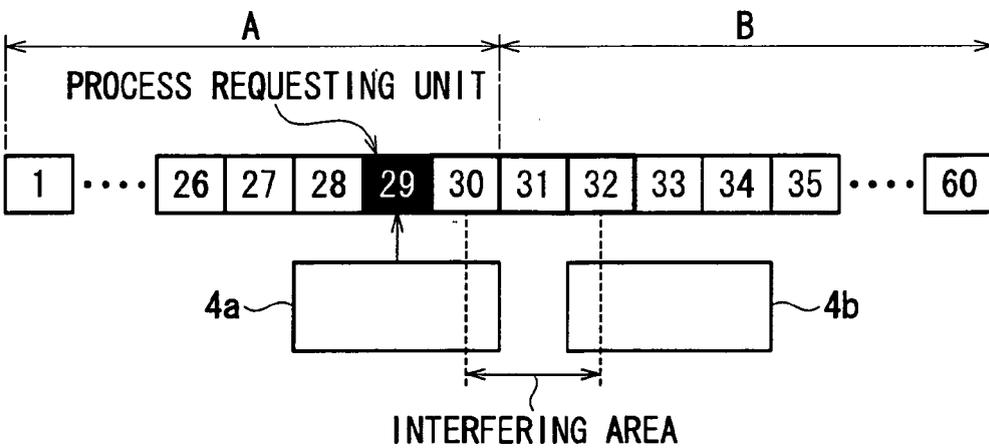


FIGURE 7

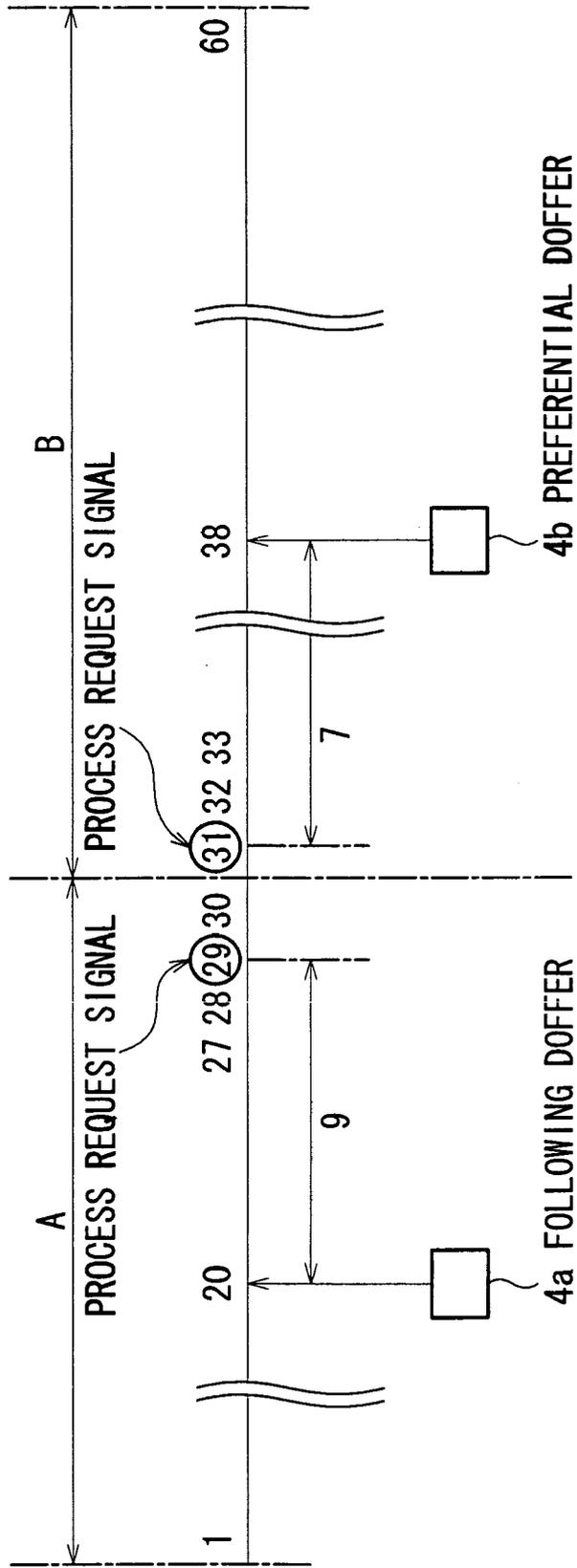


FIGURE 8

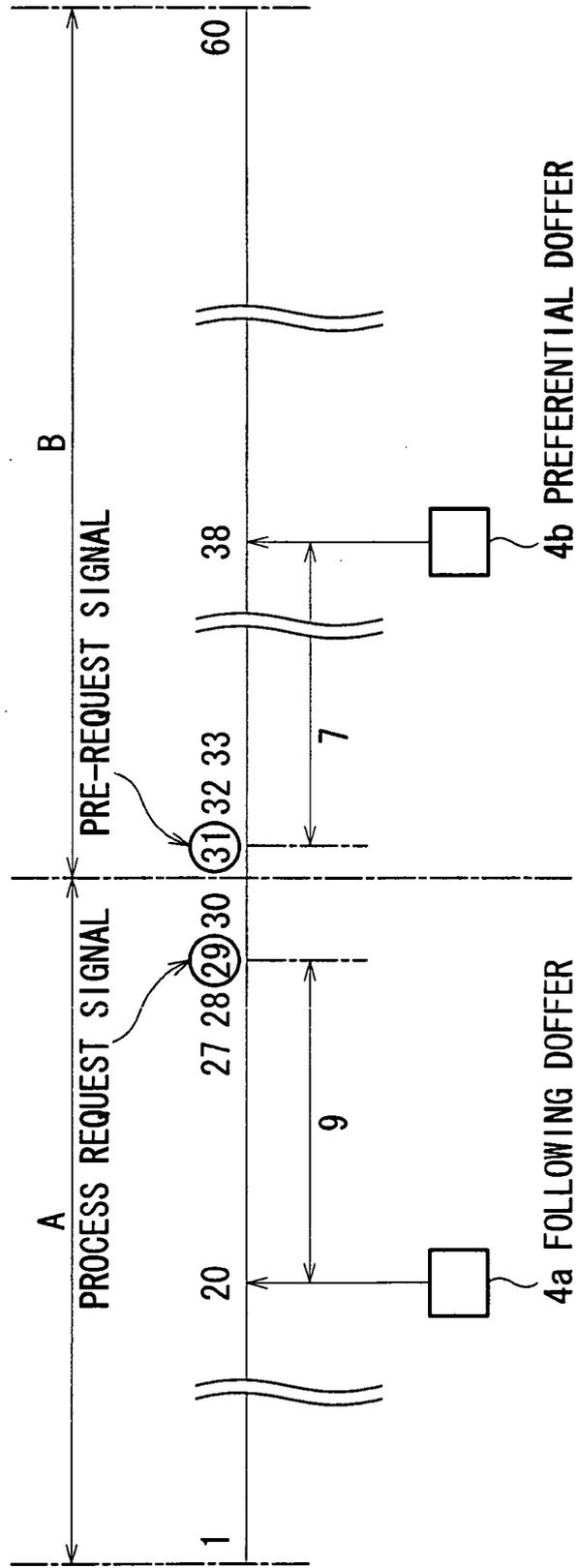
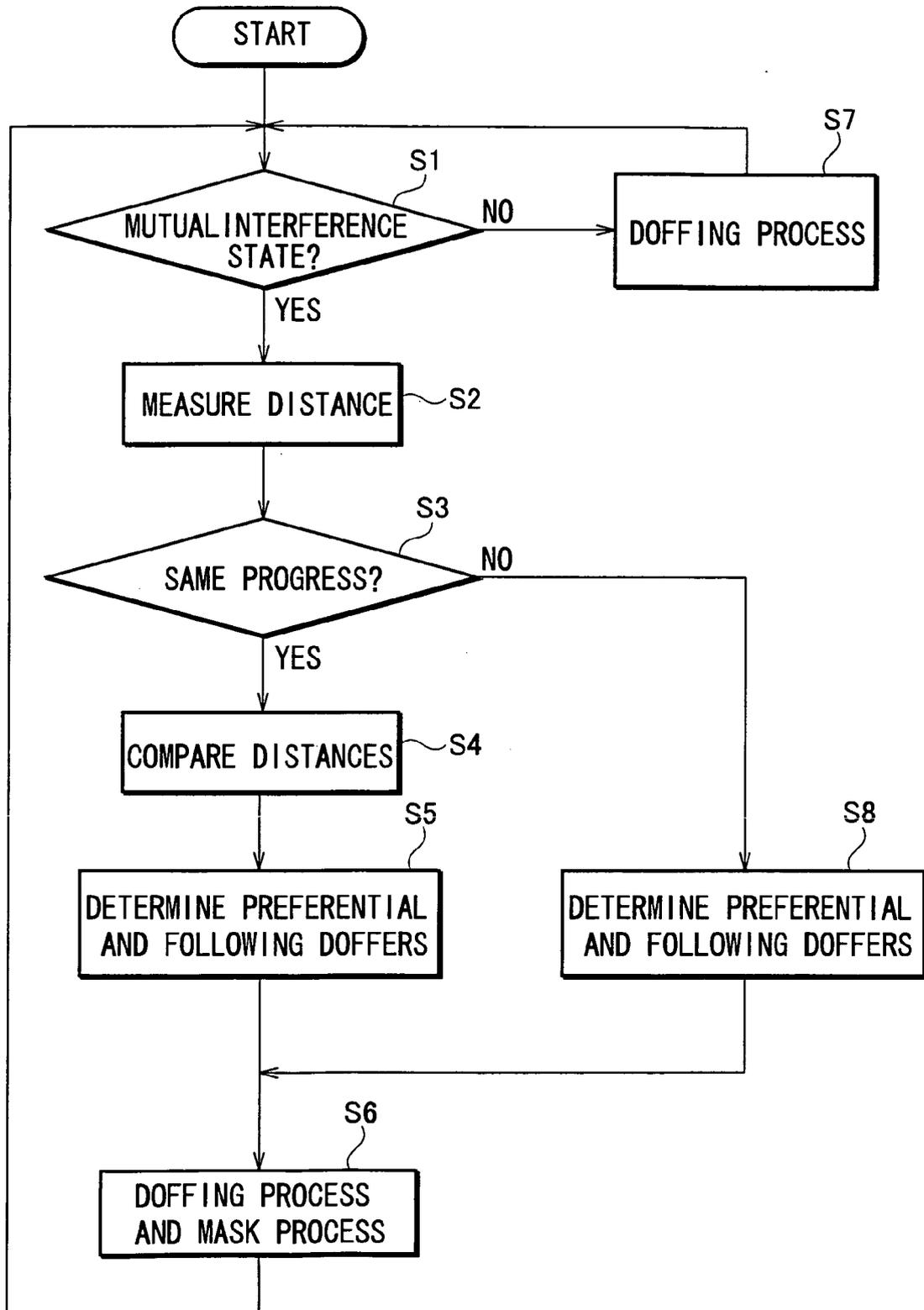


FIGURE 9





DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	DE 24 54 483 A1 (SCHLAFHORST & CO W) 20 May 1976 (1976-05-20)	1	INV. B65H54/26
A	* page 7 - page 8; figure * -----	3	
Y	EP 1 600 413 A (MURATA MACHINERY LTD [JP]) 30 November 2005 (2005-11-30)	1	
A	* column 8, lines 15-26 * * column 10, line 32 - column 12, line 14 * * column 17, line 27 - line 37; figures * -----	3	
A	DE 10 2004 035261 A1 (SAURER GMBH & CO KG [DE]) 16 February 2006 (2006-02-16) * paragraphs [0037], [0041], [0049], [0056] - [0058]; figures * -----	1,3	
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (IPC)
			B65H D01H
Place of search		Date of completion of the search	Examiner
The Hague		9 August 2007	Lemmen, René
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09-08-2007

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