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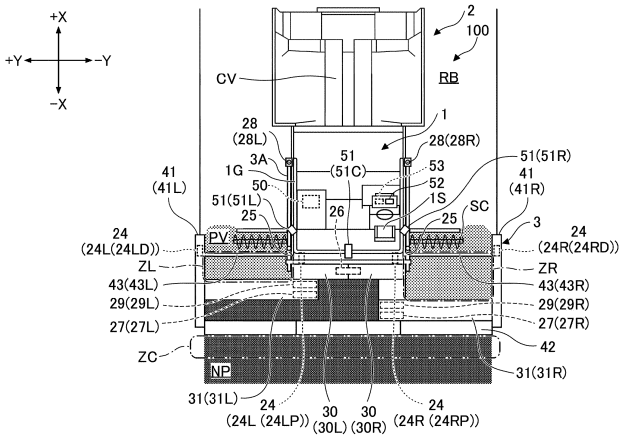
(54) ASPHALT FINISHER

(57) An asphalt finisher (100) includes a tractor (1), a hopper (2), a conveyor (CV), a screw (SC), a screed (3), a mold board (43), a mold board elevating device (24) that moves the mold board (43) up and down, a controller (50), and an information acquisition device (51). The screed (3) includes a front screed (30) and a rear screed (31) that are shifted from each other in a vehicle length direction. The information acquisition device (51) obtains information on a pavement material held by the rear screed (31). The controller (50) adjusts the height of the mold board (43) by driving the mold board elevating device (24) based on the information obtained by the information acquisition device (51).

FIG.1B



EP 3 951 062 A1

Description

TECHNICAL FIELD

[0001] This disclosure relates to an asphalt finisher.

BACKGROUND ART

[0002] A known asphalt finisher includes a rear screed that can be extended and retracted in the lateral direction with respect to a front screed (see Patent Document 1). This asphalt finisher can increase the width of a road to be paved by extending the rear screed.

[0003] This asphalt finisher travels while holding a pavement material in front of the rear screed such that the amount of the pavement material to be compacted by the rear screed does not become insufficient. The amount of the pavement material held in front of the rear screed is determined by the height of a mold board disposed between a screw and the rear screed in the traveling direction.

[0004] The amount of the pavement material held in front of the rear screed basically increases as the height of the mold board increases. This is because the amount of the pavement material that passes under the mold board increases as the height of the mold board increases.

[RELATED-ART DOCUMENT]

[Patent Document]

[0005] [Patent Document 1] Japanese Unexamined Patent Publication No. 2017-160636

DISCLOSURE OF INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0006] However, if the height of the mold board is too high, the amount of the pavement material held in front of the rear screed excessively increases, and the pavement material may go over the rear screed and overflow onto a paved surface behind the rear screed.

[0007] On the other hand, if the height of the mold board is too low, the amount of the pavement material held in front of the rear screed becomes insufficient, the amount of the pavement material to be compacted by the rear screed becomes insufficient, and roughness such as a dent may be formed on the paved surface due to the insufficient amount of the pavement material.

[0008] Thus the above-described asphalt finisher may reduce the quality of a paved surface in both cases where the mold board is too high and too low. Therefore, it is desired to provide an asphalt finisher that can suppress the reduction in the quality of a paved surface.

MEANS FOR SOLVING THE PROBLEMS

[0009] An asphalt finisher according to an embodiment of the present invention includes a tractor, a hopper that is disposed in front of the tractor and configured to receive a pavement material, a conveyor configured to convey the pavement material in the hopper to a rear side of the tractor, a screw configured to spread the pavement material conveyed by the conveyor at the rear side of the tractor, a screed configured to compact the pavement material at a rear side of the screw, a mold board attached to a front part of the screed, an elevating device configured to move the mold board up and down, an information acquisition device configured to obtain information on the pavement material held by the screed, and a control device. The screed includes a front screed and a rear screed that are shifted from each other in a vehicle length direction, and the control device is configured to adjust the height of the mold board by driving the elevating device based on the information obtained by the information acquisition device.

ADVANTAGEOUS EFFECT OF THE INVENTION

[0010] The above configuration makes it possible to provide an asphalt finisher that can suppress the reduction in the quality of a paved surface.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011]

FIG. 1A is a side view of an asphalt finisher according to an embodiment of the present invention;
FIG. 1B is a top view of the asphalt finisher according to the embodiment of the present invention;
FIG. 1C is a rear view of the asphalt finisher according to the embodiment of the present invention;
FIG. 2 is a block diagram illustrating an example of a configuration of a mold board elevating system;
FIG. 3A is a drawing illustrating an example of a screen displayed on a display device;
FIG. 3B is a drawing illustrating an example of a screen displayed on the display device; and
FIG. 4 is a flowchart illustrating a process.

DESCRIPTION OF EMBODIMENTS

[0012] FIGs. 1A to 1C are drawings illustrating an asphalt finisher 100, which is an example of a road machine according to an embodiment of the present invention. Specifically, FIG. 1A is a side view of the asphalt finisher 100, FIG. 1B is a top view of the asphalt finisher 100, and FIG. 1C is a rear view of the asphalt finisher 100.

[0013] The asphalt finisher 100 mainly includes a tractor 1, a hopper 2, and a screed 3. In the descriptions below, the direction (+X direction) of the hopper 2 seen from the tractor 1 is referred to as "front", and the direction

(-X direction) of the screed 3 seen from the tractor 1 is referred to as "rear".

[0014] The tractor 1 is a mechanism for causing the asphalt finisher 100 to travel. In the present embodiment, the tractor 1 moves the asphalt finisher 100 by rotating rear wheels 5 with a rear wheel drive hydraulic motor and rotating front wheels 6 with a front wheel drive hydraulic motor. The rear wheel drive hydraulic motor and the front wheel drive hydraulic motor are rotated by a hydraulic oil supplied from a hydraulic pump. The rear wheels 5 and the front wheels 6 may be replaced by crawlers.

[0015] A controller 50 is a control device that controls the asphalt finisher 100. In the present embodiment, the controller 50 includes a microcomputer including a CPU, a volatile storage device, and a non-volatile storage device, and is provided in the tractor 1. Functional components corresponding to functions of the controller 50 are implemented by executing programs stored in the non-volatile storage device with the CPU. However, each functional component of the controller 50 may be implemented by, for example, hardware or firmware.

[0016] The hopper 2 is a mechanism for receiving a pavement material. In the present embodiment, the hopper 2 is disposed in front of the tractor 1 and is configured to be opened and closed in a Y-axis direction (vehicle width direction) by a hopper cylinder. The asphalt finisher 100 normally receives a pavement material from the back of a dump truck with the hopper 2 fully opened. The pavement material is, for example, an asphalt mixture. FIG. 1B illustrates a state where the hopper 2 is fully opened. An operator of the asphalt finisher 100 normally closes the hopper 2 when the pavement material in the hopper 2 decreases to gather the pavement material near the inner wall of the hopper 2 to the central portion of the hopper 2. This is to enable a conveyor CV in the center of the hopper 2 to convey the pavement material to the rear side of the tractor 1. The pavement material conveyed to the rear side of the tractor 1 is spread by a screw SC in the vehicle width direction at a position behind the tractor 1 and in front of the screed 3. In the present embodiment, the screw SC is in a state where extension screws are arranged in the lateral direction and connected to each other. In FIGs. 1A and 1B, a pavement material PV spread by the screw SC is indicated by coarse (thin) hatching.

[0017] The screed 3 is a mechanism for compacting the pavement material PV. In the present embodiment, the screed 3 includes a front screed 30 and a rear screed 31. The front screed 30 includes a left front screed 30L and a right front screed 30R, and the rear screed 31 includes a left rear screed 31L and a right rear screed 31R.

[0018] The screed 3 is a floating screed towed by the tractor 1 and is connected to the tractor 1 via a leveling arm 3A. The screed 3 is moved up and down together with the leveling arm 3A by the expansion and retraction of a screed lift cylinder 25.

[0019] A leveling cylinder 28 is a hydraulic cylinder that moves a front end portion of the leveling arm 3A up and down to adjust the leveling thickness of the pavement material. In the present embodiment, the leveling cylinder 28 includes a left leveling cylinder 28L and a right leveling cylinder 28R.

[0020] In the present embodiment, the rear screed 31 is configured to be extended and retracted in the vehicle width direction by a telescopic cylinder (not shown). Specifically, the left rear screed 31L is extended and retracted in the vehicle width direction by a left telescopic cylinder (not shown), and the right rear screed 31R is extended and retracted in the vehicle width direction by a right telescopic cylinder (not shown). That is, the left rear screed 31L and the right rear screed 31R can be extended and retracted independently of each other. Alternatively, the rear screed 31 may be a detachable fixed (non-extendable) screed that is attached with, for example, a crane when the rear screed 31 is used.

[0021] A screed elevating device 29 is attached to a joint between the front screed 30 and the rear screed 31. The screed elevating device 29 is configured to be able to move the rear screed 31 up and down with respect to the front screed 30. In the present embodiment, the screed elevating device 29 rotates a screed elevating motor used as a hydraulic actuator in response to a control command from the controller 50 to drive a rotation/linear motion conversion mechanism attached to the rear screed 31 and thereby move the rear screed 31 up and down. The screed elevating device 29 includes a left screed elevating device 29L that moves the left rear screed 31L up and down and a right screed elevating device 29R that moves the right rear screed 31R up and down. The rotation/linear motion conversion mechanism is, for example, a bolt-nut mechanism. The rotation/linear motion conversion mechanism may be a different type of mechanism such as a ball screw mechanism or a rack and pinion mechanism. The screed elevating motor may instead be an electric motor. The screed elevating device 29 may also be a hydraulic cylinder.

[0022] A side plate 41 is configured to prevent the pavement material PV from spreading in the vehicle width direction. In the present embodiment, the side plate 41 includes a left side plate 41L fixed to the left end of the left rear screed 31L and a right side plate 41R fixed to the right end of the right rear screed 31R. A screed step 42 is a component that constitutes a scaffold used when an operator works at a position behind the screed 3.

[0023] A mold board 43 is disposed in front of the screed 3. The mold board 43 includes a left mold board 43L and a right mold board 43R. The left mold board 43L is configured to adjust the holding amount of the left rear screed 31L, which indicates the amount of the pavement material PV retained in front of the left rear screed 31L. The right mold board 43R is configured to adjust the holding amount of the right rear screed 31R, which indicates the amount of the pavement material PV retained in front of the right rear screed 31R. The pavement material PV passes through a gap between the lower end of the left mold board 43L and the roadbed RB and reaches a po-

sition in front of the left rear screed 31L. Also, the pavement material PV passes through a gap between the lower end of the right mold board 43R and the roadbed RB and reaches a position in front of the right rear screed 31R.

[0024] In the present embodiment, the mold board 43 is configured to be extended and retracted in the vehicle width direction together with the rear screed 31. Alternatively, similarly to the rear screed 31, the mold board 43 may be a detachable, fixed (non-extendable) mold board that is attached when used. Also, the mold board 43 is configured to be moved up and down by a mold board elevating device 24.

[0025] The mold board elevating device 24 is a mechanism for moving the mold board 43 up and down. In the present embodiment, the mold board elevating device 24 includes a left mold board elevating device 24L and a right mold board elevating device 24R.

[0026] The left mold board elevating device 24L is a mechanism for moving the left mold board 43L up and down, and includes a left outer elevating device 24LD and a left inner elevating device 24LP. The left outer elevating device 24LD is a mechanism that moves the left end (distal end) of the left mold board 43L up and down, and the left inner elevating device 24LP is a mechanism that moves the right end (proximal end) of the left mold board 43L up and down.

[0027] The right mold board elevating device 24R is a mechanism for moving the right mold board 43R up and down, and includes a right outer elevating device 24RD and a right inner elevating device 24RP. The right outer elevating device 24RD is a mechanism that moves the right end (distal end) of the right mold board 43R up and down, and the right inner elevating device 24RP is a mechanism that moves the left end (proximal end) of the right mold board 43R up and down.

[0028] Each of the left outer elevating device 24LD, the left inner elevating device 24LP, the right outer elevating device 24RD, and the right inner elevating device 24RP may be implemented by a hydraulic cylinder, an electric cylinder, or a combination of a hydraulic motor or an electric motor and a rotation/linear motion conversion mechanism.

[0029] One of the left outer elevating device 24LD and the left inner elevating device 24LP may be omitted. For example, when the left outer elevating device 24LD is omitted, the left end (distal end) of the left mold board 43L is supported by the left side plate so as to be slidable in the vertical direction (Z-axis direction) and is moved up and down along with the vertical movement of the right end (proximal end) of the left mold board 43L moved by the left inner elevating device 24LP. The same applies to a case where the left inner elevating device 24LP is omitted.

[0030] Similarly, one of the right outer elevating device 24RD and the right inner elevating device 24RP may be omitted. For example, when the right inner elevating device 24RP is omitted, the left end (proximal end) of the right mold board 43R is supported by the right front screed 30R so as to be slidable in the vertical direction (Z-axis direction) and is moved up and down along with the vertical movement of the right end (distal end) of the right mold board 43R moved by the right outer elevating device 24RD. The same applies to a case where the right outer elevating device 24RD is omitted.

[0031] A center crown device 26 is provided on the front screed 30. The center crown device 26 is a mechanism configured to extend and contract a turnbuckle attached between the left front screed 30L and the right front screed 30R and thereby adjust the angle between the lower surface of the left front screed 30L (a left front screed plate) and the lower surface of the right front screed 30R (a right front screed plate) seen from behind. For example, the center crown device 26 rotates the body of the turnbuckle by rotating a hydraulic motor in response to a control command from the controller 50 and thereby extends and contracts the turnbuckle.

[0032] A slope crown device 27 is provided between the front screed 30 and the rear screed 31. The slope crown device 27 includes a left slope crown device 27L and a right slope crown device 27R. Specifically, the left slope crown device 27L is disposed between the left front screed 30L and the left rear screed 31L, and the right slope crown device 27R is disposed between the right front screed 30R and the right rear screed 31R.

[0033] The left slope crown device 27L is a mechanism that extends and contracts a turnbuckle attached between the left front screed 30L and the left rear screed 31L and thereby adjusts the angle between the lower surface of the left front screed 30L (a left front screed plate) and the lower surface of the left rear screed 31L (a left rear screed plate) seen from behind. For example, the left slope crown device 27L rotates the body of the turnbuckle by rotating a hydraulic motor in response to a control command from the controller 50, and thereby extends and contracts the turnbuckle. The same applies to the right slope crown device 27R.

[0034] On the top of the tractor 1, a guide rail 1G, which can be used as a handrail by an operator of the asphalt finisher 100, is provided. Examples of operators of the asphalt finisher 100 include an operator who operates the tractor 1 and an operator (for example, an assistant operator) who operates the screed 3. An information acquisition device 51 is attached to the guide rail 1G. The information acquisition device 51 may instead be attached to a canopy or attached directly to the body of the tractor 1. Also, the information acquisition device 51 may be attached to the front screed 30 or the rear screed 31.

[0035] The information acquisition device 51 is configured to obtain information on the pavement material PV. In the present embodiment, the information acquisition device 51 is a LIDAR configured to measure the distance to an object existing around the asphalt finisher 100, and its measurement range includes the space in front of the rear screed 31. Also, the LIDAR is configured to be able to measure, for example, the distance between each of

one million or more points in the measurement range and the LIDAR (reference point).

[0036] Specifically, the information acquisition device 51 includes a left information acquisition device 51L, a right information acquisition device 51R, and a rear information acquisition device 51C attached to the guide rail 1G. The left information acquisition device 51L is configured to be able to obtain information on the pavement material PV held by the left rear screed 31L. The right information acquisition device 51R is configured to obtain information on the pavement material PV held by the right rear screed 31R. The rear information acquisition device 51C is configured to obtain information on the surface of the pavement material PV compacted by the screed 3.

[0037] For example, a measurement range ZL of the left information acquisition device 51L is set such that the amount of the pavement material PV retained in the space surrounded by the left front screed 30L, the left rear screed 31L, the left side plate 41L, and the left mold board 43L can be detected as the holding amount of the left rear screed 31L. Similarly, a measurement range ZR of the right information acquisition device 51R is set, for example, such that the amount of the pavement material PV retained in the space surrounded by the right front screed 30R, the right rear screed 31R, the right side plate 41R, and the right mold board 43R can be detected as the holding amount of the right rear screed 31R. The amount of the pavement material PV is measured using, for example, at least one of the volume of the pavement material PV, the height of a pile of the pavement material PV, and the distance between a reference point and the peak of the pile of the pavement material PV as a unit of measurement.

[0038] A measurement range ZC of the rear information acquisition device 51C is set to include, for example, the width of the screed 3 (i.e., the entire width of a new pavement NP).

[0039] The information acquisition device 51 may be implemented by a monocular camera, a stereo camera, a distance sensor, a millimeter wave radar, an ultrasonic sensor, a laser radar, a laser scanner, a distance image camera, or a laser range finder.

[0040] In the present embodiment, the asphalt finisher 100 is configured to obtain information on the pavement material PV in the measurement range ZL and the measurement range ZR with two information acquisition devices 51. However, the asphalt finisher 100 may be configured to obtain information on the pavement material PV in the measurement range ZL and the measurement range ZR with one information acquisition device 51 or three or more information acquisition devices 51.

[0041] The display device 52 is configured to display information on the asphalt finisher 100. In the present embodiment, the display device 52 is a liquid crystal display disposed in front of a driving seat 1S.

[0042] A communication device 53 is configured to control communications between the asphalt finisher 100 and devices outside of the asphalt finisher 100. In the present embodiment, the communication device 53 is disposed in front of the driving seat 1S.

[0043] Next, with reference to FIG. 2, a control system LS provided in the asphalt finisher 100 is described. FIG. 2 is a block diagram illustrating an example of a configuration of the control system LS.

[0044] The control system LS mainly includes the mold board elevating device 24, the center crown device 26, the slope crown device 27, the leveling cylinder 28, the screed elevating device 29, the controller 50, the left information acquisition device 51L, the right information acquisition device 51R, the display device 52, and the communication device 53.

[0045] The controller 50 includes, as functional components, an information acquisition part 50a, a crown device driving part 50b, a leveling cylinder drive part 50c, a screed elevating part 50d, and a mold board elevating part 50e. Although the information acquisition part 50a, the crown device driving part 50b, the leveling cylinder drive part 50c, the screed elevating part 50d, and the mold board elevating part 50e are illustrated as separate components for descriptive purposes, they are not necessarily physically separated and may be entirely or partially implemented by a common software component or a common hardware component.

[0046] The information acquisition part 50a is configured to obtain information on the surface of the new pavement NP. In the present embodiment, the information acquisition part 50a measures the finished surface shape of the new pavement NP based on an output of the LIDAR used as the rear information acquisition device 51C. Specifically, the information acquisition part 50a measures the finished surface shape of the new pavement NP using a local coordinate system centered on the LIDAR and a reference coordinate system. That is, the information acquisition part 50a identifies the coordinates in the reference coordinate system corresponding to each point on the surface of the new pavement NP by converting the coordinates in the local coordinate system into the coordinates in the reference coordinate system. The reference coordinate system is, for example, a world geodetic coordinate system. The world geodetic coordinate system is a three-dimensional Cartesian XYZ coordinate system in which the origin is set at the center of gravity of the earth, the X-axis is set in the direction of the intersection between the Greenwich meridian and the equator, the Y-axis is set in the direction of 90 degrees east longitude, and the Z-axis is set in the direction of the North Pole.

[0047] The information acquisition part 50a is configured to be able to measure the finished surface shape of the new pavement NP within the measurement range during pavement work, i.e., while the asphalt finisher 100 is moving forward.

[0048] The information acquisition part 50a may be configured to determine whether a step exists on the paved surface. In this case, the information acquisition part 50a may be configured to cause the display device

52 to display the determination result indicating the presence or the absence of a step. Also, when it is determined that a step exists, the information acquisition part 50a may display information indicating the position of the step.

[0049] The information acquisition part 50a may determine whether a step exists by performing image processing on an image captured by an imaging device used as the rear information acquisition device 51C. In this case, the imaging device is, for example, a monocular camera, a stereo camera, an infrared camera, a range image camera, a LIDAR. The image processing includes, for example, a binarization process, an edge detection process, and a Hough transform process.

[0050] When the size of an irregularity on the surface of the new pavement NP is greater than a predetermined value, the information acquisition part 50a may display the corresponding information on the display device 52. In this case, the information acquisition part 50a may output an alert from an audio output device (not shown).

[0051] The crown device driving part 50b is configured to drive at least one of the center crown device 26 and the slope crown device 27. In the present embodiment, the crown device driving part 50b separately drives the center crown device 26 and the slope crown device 27 by using, for example, a hydraulic pump, a hydraulic motor, and a control valve. Specifically, the crown device driving part 50b separately drives the center crown device 26 and the slope crown device 27 in response to commands entered by an operator of the asphalt finisher 100 via an input device (not shown). The crown device driving part 50b may separately and autonomously drive the center crown device 26 and the slope crown device 27 in response to control commands from the controller 50 that are different from commands entered by the operator.

[0052] The leveling cylinder drive part 50c is configured to drive the leveling cylinder 28. The leveling cylinder drive part 50c drives the leveling cylinder 28 by using, for example, a hydraulic pump and a control valve. Specifically, the leveling cylinder drive part 50c drives the leveling cylinder 28 in response to a command entered by the operator of the asphalt finisher 100 via an input device. The leveling cylinder drive part 50c may also autonomously drive the leveling cylinder 28 in response to a control command from the controller 50, which is different from the command entered by the operator.

[0053] The screed elevating part 50d is configured to drive the screed elevating device 29. The screed elevating device 29 is a mechanism that moves the rear screed 31 up and down to eliminate a step formed between a paved surface compacted by the front screed 30 and a paved surface compacted by the rear screed 31. Eliminating the step indicates preventing the step detected by the controller 50 from being continuously formed thereafter. A step that has already been formed is removed by using, for example, a rake for leveling work, a road roller, or a plate compactor.

[0054] The screed elevating part 50d operates the screed elevating device 29 by using, for example, a hydraulic pump, a hydraulic motor, and a control valve. Specifically, the screed elevating part 50d drives the screed elevating device 29 in response to a command entered by the operator of the asphalt finisher 100 via an input device. The screed elevating part 50d may also autonomously drive the screed elevating device 29 in response to a control command from the controller 50, which is different from the command entered by the operator.

[0055] When detecting a step formed between a paved surface formed by the front screed 30 and a paved surface formed by the rear screed 31, the controller 50 may output a control command to, for example, the screed elevating part 50d. In this case, the screed elevating part 50d drives the screed elevating device 29 in response to a control command from the controller 50 to eliminate the step. For example, the screed elevating part 50d drives the left screed elevating device 29L and thereby moves the left rear screed 31L up and down to eliminate a step formed between a paved surface compacted by the left front screed 30L and a paved surface compacted by the left rear screed 31L. More specifically, the screed elevating part 50d rotates a screed elevating motor used as a hydraulic actuator constituting the left screed elevating device 29L in response to a control command from the controller 50 and thereby drives a rotation/linear motion conversion mechanism attached to the left rear screed 31L to move the left rear screed 31L up and down. The right screed elevating device 29R is driven in a similar manner.

[0056] The mold board elevating part 50e is configured to drive the mold board elevating device 24. The mold board elevating device 24 is a mechanism for moving the mold board 43 up and down to adjust the holding amount of the rear screed 31.

[0057] The mold board elevating part 50e drives the mold board elevating device 24 by using, for example, a hydraulic pump, a hydraulic motor, and a control valve. Specifically, the mold board elevating part 50e drives the mold board elevating device 24 in response to a command entered by the operator of the asphalt finisher 100 via an input device. The mold board elevating part 50e may also autonomously drive the mold board elevating device 24 in response to a control command from the controller 50, which is different from the command entered by the operator.

[0058] For example, when determining that the holding amount of the left rear screed 31L is too large or too small based on an output of the left information acquisition device 51L, the controller 50 may output a control command to the mold board elevating part 50e. In this case, the mold board elevating part 50e causes the mold board elevating device 24 to adjust the height of the mold board 43 in response to the control command from the controller 50. Specifically, the mold board elevating part 50e causes the left outer elevating device 24LD and the left inner elevating device 24LP to move the left mold board 43L

up and down to adjust the amount of the pavement material PV that passes under the left mold board 43L and thereby adjust the holding amount of the left rear screed 31L. The holding amount of the right rear screed 31R is also adjusted in a similar manner.

[0059] As described above, the controller 50 may autonomously control at least one of the mold board elevating device 24, the center crown device 26, the slope crown device 27, the leveling cylinder 28, and the screed elevating device 29. Alternatively, the operator may manually control at least one of the mold board elevating device 24, the center crown device 26, the slope crown device 27, the leveling cylinder 28, and the screed elevating device 29.

[0060] Next, with reference to FIGs. 3A and 3B, a screen GX is described. The screen GX is displayed on the display device 52 by the controller 50 when the controller 50 detects that the holding amount of the rear screed 31 is too large or too small. FIG. 3A and 3B illustrate two examples of the screen GX. Specifically, FIG. 3A illustrates a screen GX that is displayed when it is detected that the holding amount of the left rear screed 31L is less than a predetermined lower limit. FIG. 3B illustrates a screen GX that is displayed when it is detected that the holding amount of the right rear screed 31R is greater than a predetermined upper limit.

[0061] The screens GX illustrated in FIGs. 3A and 3B include a machine figure GM, a pavement material graphic GP, and a road surface graphic GR as common graphics.

[0062] The machine graphic GM represents a top view of the asphalt finisher 100. In the present embodiment, the machine graphic GM represents a top view of the entire asphalt finisher 100.

[0063] The pavement material graphic GP represents a top view of the pavement material PV before being compacted by the screed 3. In the present embodiment, the pavement material graphic GP includes a left pavement material graphic GPL representing the pavement material PV held by the left rear screed 31L and a right pavement material graphic GPR representing the pavement material PV held by the right rear screed 31R. The pavement material graphic GP is displayed such that the operator can distinguish between a portion where the amount of the pavement material PV is large and a portion where the amount of the pavement material PV is small. Specifically, in the pavement material graphic GP, the portion where the amount of the pavement material PV is large is represented by fine (dark) hatching, and the portion where the amount of the pavement material PV is small is represented by coarse (light) hatching. However, the pavement material graphic GP may be displayed using at least one of a difference in color, a difference in pattern, and a difference in brightness such that the operator can distinguish between a portion where the amount of the pavement material PV is large and a portion where the amount of the pavement material PV is small.

[0064] The road surface graphic GR represents a top view of the new pavement NP. In the present embodiment, the road surface graphic GR displays the new pavement NP with a diagonal line pattern.

[0065] FIG. 3A includes graphics G11 and G21. The graphic G11 is displayed when the holding amount of the left rear screed 31L is not proper. In the present embodiment, the graphic G11 is an alert including character information such as "SHORT OF PAVEMENT MATERIAL!" regarding an abnormal state currently occurring.

[0066] The graphic G21 is displayed when the holding amount of the left rear screed 31L is improper. In the present embodiment, the graphic G21 is a balloon that includes information about an action to be taken to resolve the abnormal state currently occurring and points to the position of the measurement range ZL (see FIG. 1B). The graphic G21 displays, for example, text information such as "MOVE LEFT MOLD BOARD UPWARD" to communicate to the operator of the asphalt finisher 100 that the entire left mold board 43L is autonomously moved upward by the controller 50.

[0067] FIG. 3B includes graphics G12 and G22. The graphic G12 is displayed when the holding amount of the right rear screed 31R is improper. In the present embodiment, the graphic G12 is an alert including character information such as "TOO MUCH PAVEMENT MATERIAL!" regarding an abnormal state currently occurring.

[0068] The graphic G22 is displayed when the holding amount of the right rear screed 31R is improper. In the present embodiment, the graphic G22 is a balloon that includes information about an action to be taken to resolve the abnormal state currently occurring and points to the position of the left edge of the measurement range ZR (see FIG. 1B). For example, the graphic G22 displays text information such as "MOVE LEFT END OF RIGHT MOLD BOARD DOWNWARD" to communicate to the operator of the asphalt finisher 100 that the left end (proximal end) of the right mold board 43R is autonomously moved downward by the controller 50.

[0069] Next, with reference to FIG. 4, a process (hereafter referred to as a "height adjustment process"), which is performed by the controller 50 to adjust the height of the mold board 43 and thereby adjust the holding amount of the rear screed 31, is described. FIG. 4 is a flowchart illustrating the height adjustment process. For example, the controller 50 repeatedly performs the height adjustment process at a predetermined control cycle while the asphalt finisher 100 is moving forward.

[0070] First, the controller 50 determines whether the holding amount is insufficient on the left side (step ST1). In the present embodiment, the information acquisition part 50a of the controller 50 determines whether the holding amount of the left rear screed 31L is less than a predetermined lower limit based on an output of a LIDAR used as the left information acquisition device 51L.

[0071] When it is determined that the holding amount is insufficient on the left side (YES at step ST1), the controller 50 moves the left mold board 43L upward (step

ST2). This is to solve the shortage of the holding amount of the left rear screed 31L by increasing the amount of the pavement material PV that passes under the left mold board 43L. In the present embodiment, the information acquisition part 50a outputs a control command to cause the mold board elevating part 50e to move the left mold board 43L upward. The mold board elevating part 50e drives the left mold board elevating device 24L in response to the control command from the information acquisition part 50a to move the left mold board 43L upward.

[0072] When it is determined that the holding amount is not insufficient on the left side (NO at step ST1), the controller 50 determines whether the holding amount is excessive on the left side (step ST3). In the present embodiment, the information acquisition part 50a determines whether the holding amount of the left rear screed 31L is greater than a predetermined upper limit based on an output of a LIDAR used as the left information acquisition device 51L.

[0073] When it is determined that the holding amount is excessive on the left side (YES at step ST3), the controller 50 moves the left mold board 43L downward (step ST4). This is to reduce the amount of the pavement material PV that passes under the left mold board 43L and thereby solve the excess of the holding amount of the left rear screed 31L. In the present embodiment, the information acquisition part 50a outputs a control command to cause the mold board elevating part 50e to move the left mold board 43L downward. The mold board elevating part 50e drives the left mold board elevating device 24L in response to the control command from the information acquisition part 50a to lower the left mold board 43L.

[0074] When it is determined that the holding amount is not excessive on the left side (NO at step ST3), the controller 50 performs step ST5 without performing step ST4.

[0075] The controller 50 may be configured to determine whether the holding amount is insufficient on the left side after determining whether the holding amount is excessive on the left side. Also, the controller 50 may be configured to simultaneously determine whether the holding amount is excessive on the left side and whether the holding amount is insufficient on the left side.

[0076] Next, the controller 50 determines whether the holding amount is insufficient on the right side (step ST5). In the present embodiment, the information acquisition part 50a determines whether the holding amount of the right rear screed 31R is less than a predetermined lower limit based on an output of a LIDAR used as the right information acquisition device 51R.

[0077] When it is determined that the holding amount is insufficient on the right side (YES at step ST5), the controller 50 moves the right mold board 43R upward (step ST6). This is to increase the amount of the pavement material PV passing under the right mold board 43R and thereby solve the shortage of the holding amount of the right rear screed 31R. In the present embodiment, the information acquisition part 50a outputs a control command to cause the mold board elevating part 50e to move the right mold board 43R upward. The mold board elevating part 50e drives the right mold board elevating device 24R in response to the control command from the information acquisition part 50a to move the right mold board 43R upward.

[0078] When it is determined that the holding amount is not insufficient on the right side (NO at step ST5), the controller 50 determines whether the holding amount is excessive on the right side (step ST7). In the present embodiment, the information acquisition part 50a determines whether the holding amount of the right rear screed 31R is greater than a predetermined upper limit based on an output of a LIDAR used as the right information acquisition device 51R.

[0079] When it is determined that the holding amount is excessive on the right side (YES at step ST7), the controller 50 moves the right mold board 43R downward (step ST8). This is to reduce the amount of the pavement material PV passing under the right mold board 43R and thereby solve the excess of the holding amount of the right rear screed 31R. In the present embodiment, the information acquisition part 50a outputs a control command to cause the mold board elevating part 50e to move the right mold board 43R downward. The mold board elevating part 50e drives the right mold board elevating device 24R in response to the control command from the information acquisition part 50a to move the right mold board 43R downward.

[0080] When it is determined that the holding amount is not excessive on the right side (NO at step ST7), the controller 50 ends the current height adjustment process without performing step ST8.

[0081] The controller 50 may be configured to determine whether the holding amount is insufficient on the right side after determining whether the holding amount is excessive on the right side. Also, the controller 50 may be configured to simultaneously determine whether the holding amount is excessive on the right side and whether the holding amount is insufficient on the right side.

[0082] The controller 50 may be configured to determine how to move each of the left mold board 43L and the right mold board 43R up and down after the determination of whether the holding amount is insufficient on the right side, whether the holding amount is excessive on the right side, whether the holding amount is insufficient on the left side, and whether the holding amount is excessive on the left side is fully completed.

[0083] With the above-described configuration, the controller 50 can suppress the reduction in the quality of a paved surface by autonomously adjusting the excess and the shortage of the holding amount of the rear screed 31. This is because the controller 50 can improve at least one of the flatness of a paved surface and the homogeneity of a pavement.

[0084] The asphalt finisher 100 can automatically detect the excess and the shortage of the holding amount

of the rear screed 31 and then autonomously move the mold board 43 up or down to solve the excess and the shortage. Accordingly, the asphalt finisher 100 can, for example, prevent the pavement material PV from going over the rear screed 31 and overflowing into the rear side of the rear screed 31. Also, for example, the asphalt finisher 100 can prevent roughness such as a dent from being formed in a paved surface due to shortage of the pavement material PV.

[0085] Also, the asphalt finisher 100 can form a flat and homogeneous new pavement NP regardless of the level of skill of an operator in manual operations of the mold board elevating device 24. Therefore, the asphalt finisher 100 can maintain the quality of a formed pavement at or above a certain level.

[0086] Also, the asphalt finisher 100 may be configured to anticipate the occurrence of an excess or a shortage of the holding amount of the rear screed 31 and to autonomously move the mold board 43 up or down to prevent the excess or the shortage before it occurs. In this case, the controller 50 may be configured to anticipate the occurrence of an excess or a shortage of the holding amount of the rear screed 31 based on outputs of the information acquisition device 51 that are continuously stored over a predetermined period of time.

[0087] As described above, the asphalt finisher 100 according to the embodiment of the present invention includes the tractor 1, the hopper 2 that is disposed in front of the tractor 1 and receives a pavement material, the conveyor CV that conveys the pavement material in the hopper 2 to the rear side of the tractor 1, the screw SC that spreads the pavement material conveyed by the conveyor CV at the rear side of the tractor 1, the screed 3 that compacts the pavement material PV at the rear side of the screw SC, the mold board 43 attached to a front part of the screed 3, the mold board elevating device 24 used as an elevating device for moving the mold board 43 up and down, the information acquisition device 51 that obtains information on the pavement material PV being held by the screed 3, and the controller 50 used as a control device. The screed 3 includes the front screed 30 and the rear screed 31 that are shifted from each other in the vehicle length direction. The controller 50 is configured to drive the mold board elevating device 24 based on information obtained by the information acquisition device 51 and thereby adjust the height of the mold board 43.

[0088] With this configuration, the asphalt finisher 100 can adjust the holding amount of the pavement material PV held by the rear screed 31 such that the holding amount falls within a predetermined range. Accordingly, the asphalt finisher 100 can prevent the reduction in the quality of a paved surface by preventing the pavement material PV from overflowing onto the new pavement NP due to an excessive holding amount and by preventing roughness such as a dent from being formed on a paved surface due to the shortage of the holding amount. Accordingly, the asphalt finisher 100 can reduce the amount of work related to repair of a paved surface and can improve the efficiency of the entire pavement work.

[0089] The controller 50 is typically configured to move the mold board 43 upward when determining that the holding amount of the rear screed 31 is less than a predetermined lower limit based on information obtained by the information acquisition device 51. This is to increase the holding amount of the rear screed 31.

[0090] Also, the controller 50 is typically configured to move the mold board 43 downward when determining that the holding amount of the rear screed 31 is larger than a predetermined upper limit based on information obtained by the information acquisition device 51. This is to decrease the holding amount of the rear screed 31.

[0091] The holding amount may be represented by, for example, the height of a pile of the pavement material PV with respect to the roadbed RB or the perpendicular distance between the reference point of the LIDAR used as the information acquisition device 51 and the peak of a pile of the pavement material PV.

[0092] Alternatively, the holding amount may be represented by the volume of the pavement material PV. Specifically, the holding amount of the right rear screed 31R may be represented by, for example, the volume of the pavement material PV retained in a space surrounded by the right front screed 30R, the right rear screed 31R, the right side plate 41R, and the right mold board 43R.

[0093] The screed 3 includes, for example, the front screed 30, the left rear screed 31L, and the right rear screed 31R. In this case, the mold board 43 includes the left mold board 43L corresponding to the left rear screed 31L and the right mold board 43R corresponding to the right rear screed 31R. The controller 50 is configured to be able to independently adjust the heights of the left mold board 43L and the right mold board 43R.

[0094] With this configuration, the asphalt finisher 100 can separately adjust the holding amount of the pavement material PV held by the left rear screed 31L and the holding amount of the pavement material PV held by the right rear screed 31R. Therefore, the asphalt finisher 100 can flexibly deal with a case where the excess and shortage states of the holding amounts on the right side and the left side are different from each other. For example, the asphalt finisher 100 can flexibly deal with a case where the degree of extension of the left rear screed 31L and the degree of extension of the right rear screed 31R are different from each other.

[0095] The elevating device may include a first elevating device that moves one end of the mold board 43 up and down and a second elevating device that moves the other end of the mold board up and down. Specifically, as described in the above embodiment, the mold board elevating device 24 used as the elevating device may include the left outer elevating device 24LD that moves the left end (distal end) of the left mold board 43L up and down and the left inner elevating device 24LP that moves the right end (proximal end) of the left mold board 43L

up and down. Similarly, the mold board elevating device 24 used as the elevating device may include the right outer elevating device 24RD that moves the right end (distal end) of the right mold board 43R up and down and the right inner elevating device 24RP that moves the left end (proximal end) of the right mold board 43R up and down.

[0096] With this configuration, the asphalt finisher 100 can, for example, make the heights of the left end (proximal end) and the right end (distal end) of the right mold board 43R different from each other. That is, the asphalt finisher 100 can properly deal with even a case where the holding amount on the front right side of the right rear screed 31R is proper but the holding amount on the front left side of the right rear screed 31R is too large as exemplified in FIG. 3B. In this case, the asphalt finisher 100 can reduce the holding amount on the front left side of the right rear screed 31R while maintaining the proper holding amount on the front right side of the right rear screed 31R by moving the left end (proximal end) of the right mold board 43R downward while maintaining the height of the right end (distal end) of the right mold board 43R.

[0097] In the above-described embodiment, the information acquisition device 51 is a LIDAR. However, the information acquisition device 51 may also be a monocular camera or a combination of a monocular camera and a LIDAR. Also, the information acquisition device 51 may be a stereo camera, a distance sensor, a millimeter wave radar, an ultrasonic sensor, a laser radar, a laser scanner, a distance image camera, a laser range finder, or any combination of them. With this configuration, the asphalt finisher 100 can suppress the reduction in the quality of a paved surface with a relatively simple configuration.

[0098] A preferred embodiment of the present invention is described above. However, the present invention is not limited to the above-described embodiment, and various modifications or substitutions may be applied to the above-described embodiment without departing from the scope of the present invention. Also, the features described in the above embodiment may be combined as needed as long as they do not technically contradict with each other.

[0099] For example, in the above-described embodiment, the controller 50 is configured to automatically detect an excess and a shortage of the holding amount and then move the mold board 43 up and down to autonomously solve the excess and the shortage. However, the controller 50 may be configured to inform the operator that an excess or a shortage of the holding amount is detected and then prompt the operator to move the mold board 43 up or down. In this case, the controller 50 may support the manual operation of the mold board elevating device 24 by the operator by using at least one of sound, light, and vibration.

[0100] The present application is based on and claims the benefit of priority of Japanese Patent Application No. 2019-066400 filed on March 29, 2019, the entire contents of which are hereby incorporated herein by reference.

EXPLANATION OF REFERENCE NUMERALS

[0101] 1 ... tractor 1G ... guide rail 1S ... driving seat 2 ... hopper 3 ... screed 3A ... leveling arm 5 ... rear wheel 6 ... front wheel 24 ... mold board elevating device 25 ... screed lift cylinder 26 ... center crown device 27 ... slope crown device 28 ... leveling cylinder 29 ... screed elevating device 30 ... front screed 31 ... rear screed 41 ... side plate 42 ... screed step 43 ... mold board 50 ... controller 50a ... information acquisition part 50b ... crown device driving part 50c ... leveling cylinder drive part 50d ... screed elevating part 50e ... mold board elevating part 51 ... information acquisition device 52 ... display device 53 ... communication device 100 ... asphalt finisher AP ... feature CV ... conveyor NP ... new pavement PV ... pavement material RB ... roadbed SC ... screw

Claims

1. An asphalt finisher, comprising:

a tractor;
a hopper that is disposed in front of the tractor and configured to receive a pavement material;
a conveyor configured to convey the pavement material in the hopper to a rear side of the tractor;
a screw configured to spread the pavement material conveyed by the conveyor at the rear side of the tractor;
a screed configured to compact the pavement material at a rear side of the screw;
a mold board attached to a front part of the screed;
an elevating device configured to move the mold board up and down;
an information acquisition device configured to obtain information on the pavement material held by the screed; and
a control device, wherein
the screed includes a front screed and a rear screed that are shifted from each other in a vehicle length direction; and
the control device is configured to adjust a height of the mold board by driving the elevating device based on the information obtained by the information acquisition device.

2. The asphalt finisher as claimed in claim 1, wherein the control device is configured to move the mold board upward when determining that a holding amount of the screed is less than a predetermined lower limit based on the information obtained by the information acquisition device.

3. The asphalt finisher as claimed in claim 1, wherein

the control device is configured to move the mold board downward when determining that a holding amount of the screed is greater than a predetermined upper limit based on the information obtained by the information acquisition device.

4. The asphalt finisher as claimed in claim 1, wherein

the screed includes a front screed, a left rear screed, and a right rear screed;
the mold board includes a left mold board corresponding to the left rear screed and a right mold board corresponding to the right rear screed; and
the control device is configured to be able to independently adjust heights of the left mold board and the right mold board.

5. The asphalt finisher as claimed in claim 1, wherein the elevating device includes a first elevating device configured to move one end of the mold board up and down and a second elevating device configured to move another end of the mold board up and down.

6. The asphalt finisher as claimed in claim 1, wherein the information acquisition device is a camera or a LIDAR.

Amended claims under Art. 19.1 PCT

1. An asphalt finisher, comprising:

a tractor;
a hopper that is disposed in front of the tractor and configured to receive a pavement material;
a conveyor configured to convey the pavement material in the hopper to a rear side of the tractor;
a screw configured to spread the pavement material conveyed by the conveyor at the rear side of the tractor;
a screed configured to compact the pavement material at a rear side of the screw;
a mold board attached to a front part of the screed;
an elevating device configured to move the mold board up and down;
an information acquisition device configured to obtain information on the pavement material held by the screed; and
a control device, wherein
the screed includes a front screed and a rear screed that are shifted from each other in a vehicle length direction; and
the control device is configured to adjust a height of the mold board by driving the elevating device based on the information obtained by the information acquisition device.

2. The asphalt finisher as claimed in claim 1, wherein the control device is configured to move the mold board upward when determining that a holding amount of the screed is less than a predetermined lower limit based on the information obtained by the information acquisition device.

3. The asphalt finisher as claimed in claim 1, wherein the control device is configured to move the mold board downward when determining that a holding amount of the screed is greater than a predetermined upper limit based on the information obtained by the information acquisition device.

4. The asphalt finisher as claimed in claim 1, wherein

the screed includes a front screed, a left rear screed, and a right rear screed;
the mold board includes a left mold board corresponding to the left rear screed and a right mold board corresponding to the right rear screed; and
the control device is configured to be able to independently adjust heights of the left mold board and the right mold board.

5. The asphalt finisher as claimed in claim 1, wherein the elevating device includes a first elevating device configured to move one end of the mold board up and down and a second elevating device configured to move another end of the mold board up and down.

6. The asphalt finisher as claimed in claim 1, wherein the information acquisition device is a camera or a LIDAR.

7. New) The asphalt finisher as claimed in claim 1, wherein the control device is configured to display a top view image of an area between the rear screed and the mold board on a display device.

8. New) The asphalt finisher as claimed in claim 1, wherein the control device is configured to display a pavement material graphic on a display device based on a holding amount of the screed obtained by the information acquisition device.

9. New) The asphalt finisher as claimed in claim 1, wherein the control device is configured to display an alert on a display device based on a holding amount of the screed obtained by the information acquisition device.

10. New) The asphalt finisher as claimed in claim 1, wherein when a holding amount of the screed obtained by the information acquisition device is in an improper state, the control device displays information regarding an action to be taken to solve the im-

proper state on a display device.

11. New) The asphalt finisher as claimed in claim 1, wherein the information acquisition device is configured to measure a finished surface shape of a new pavement.

FIG.1A

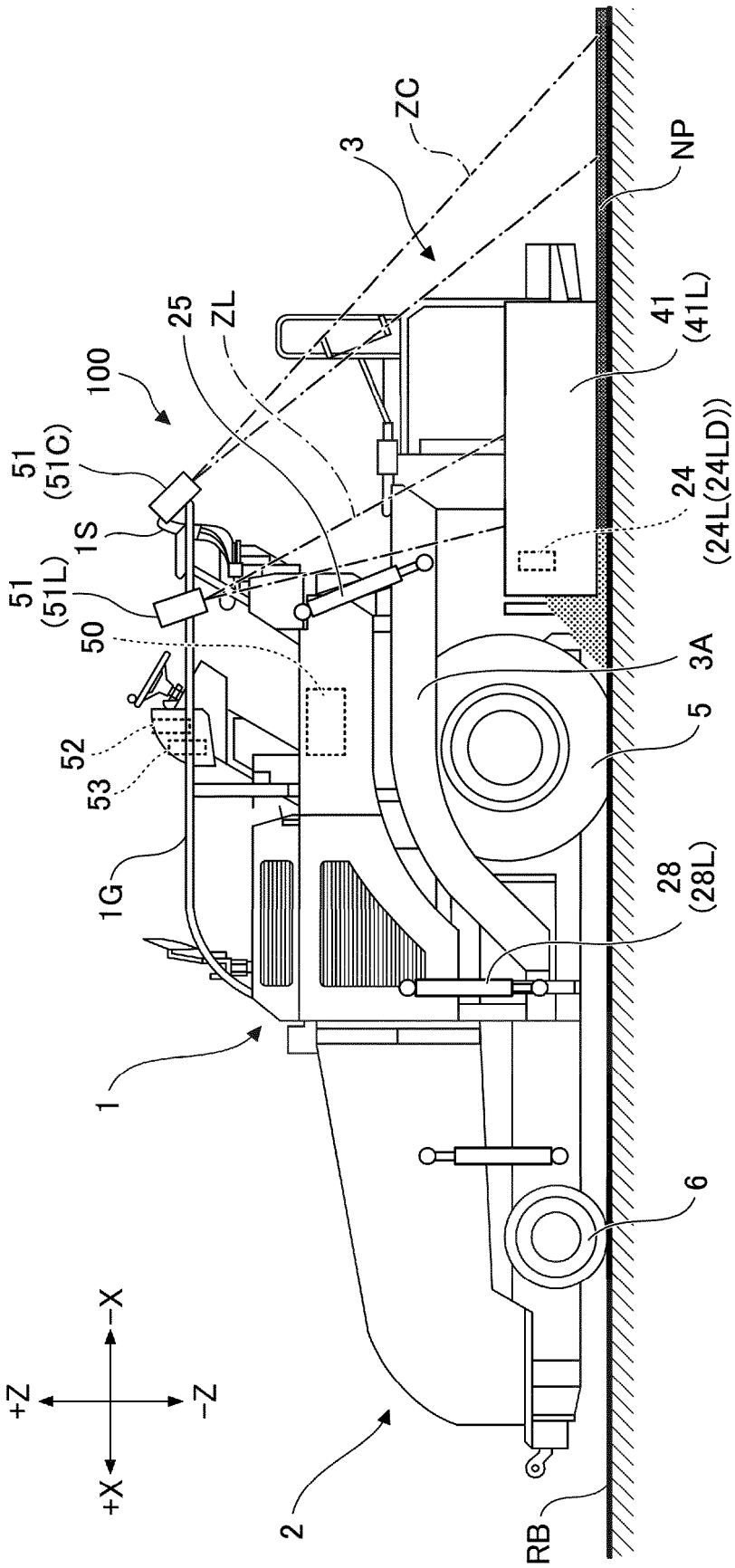
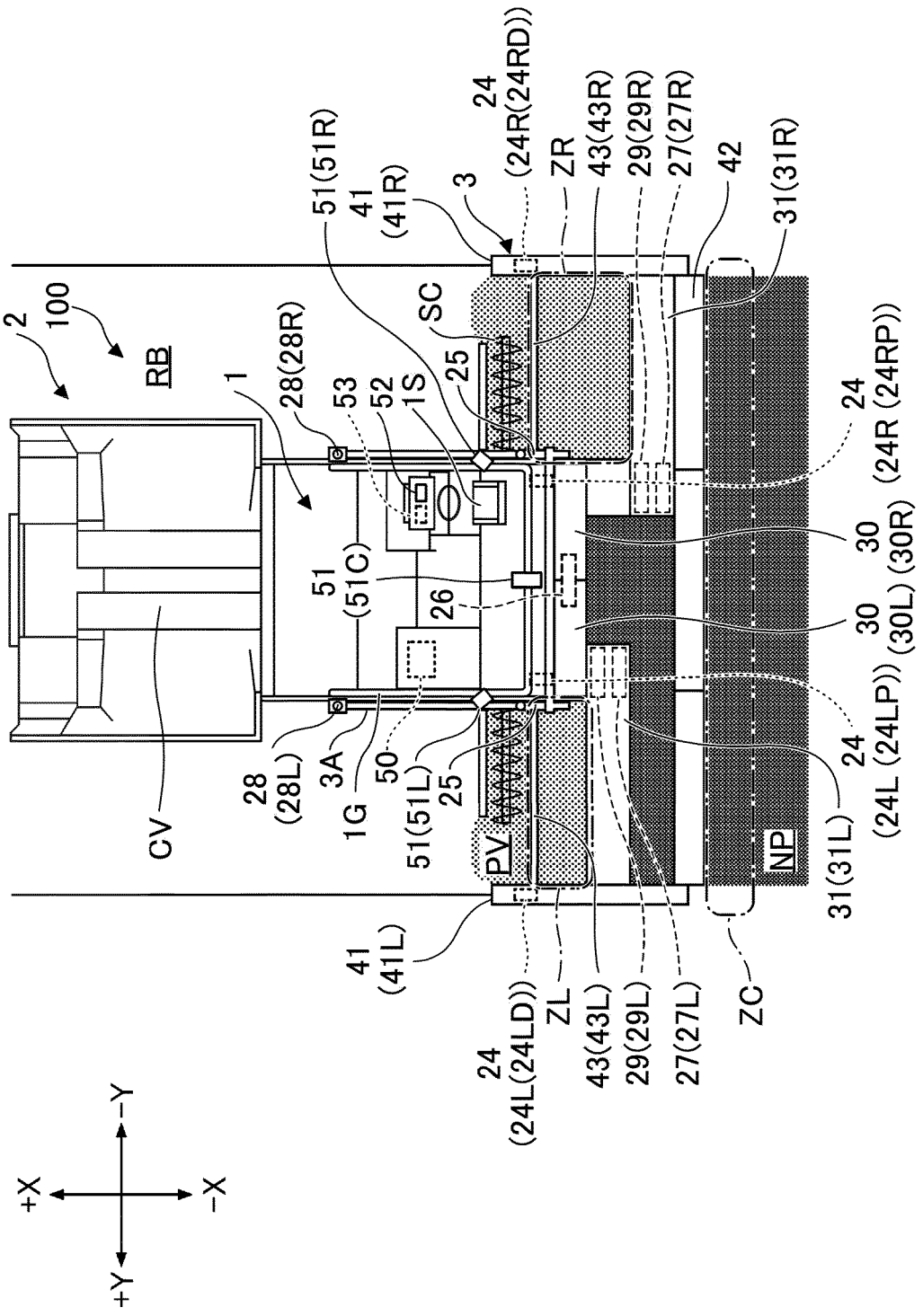

ZC
3
NP
25
ZL
41
(41L)
100
51
(51C)
1S
24
(24L(24LD))
51
(51L)
50
3A
5
52
53
1G
28
(28L)
1
6
+Z
−Z
−X
+X
2
RB

FIG.1B


2
100
RB
1
28(28R)
53
52
1S
SC
25
51(51R)
41
(41R)
3
24
(24R(24RD))
ZR
43(43R)
29(29R)
27(27R)
42
31(31R)
24
(24R (24RP))
30
(30R)
30
(30L)
24
(24L (24LP))
31(31L)
NP
ZC
24
(24L(24LD))
ZL
43(43L)
29(43L)
27(27L)
41
(41L)
PV
51(51L)
25
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CV
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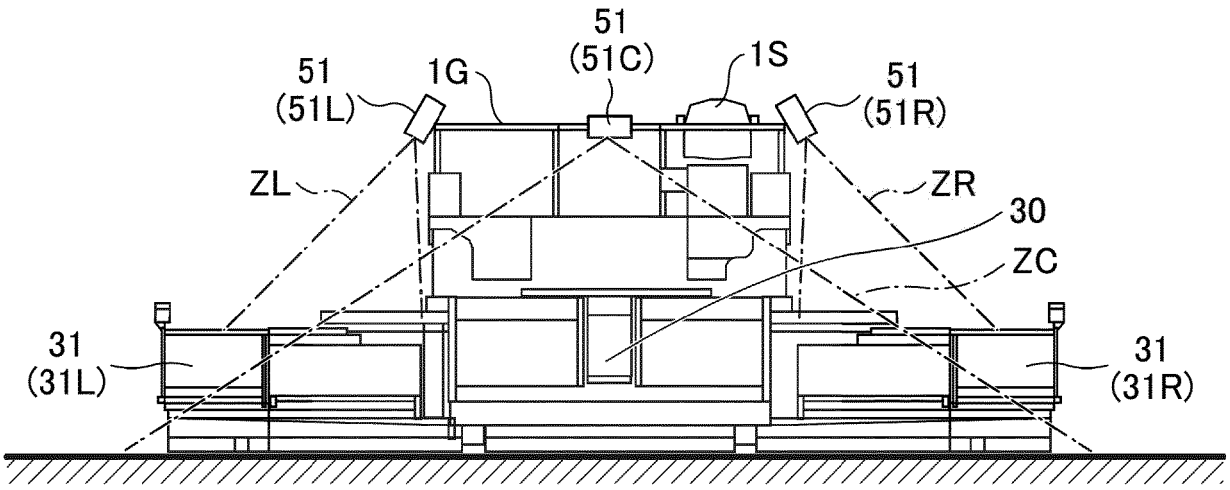
51
(51C)
+X
-X
+Y
-Y

FIG.1C



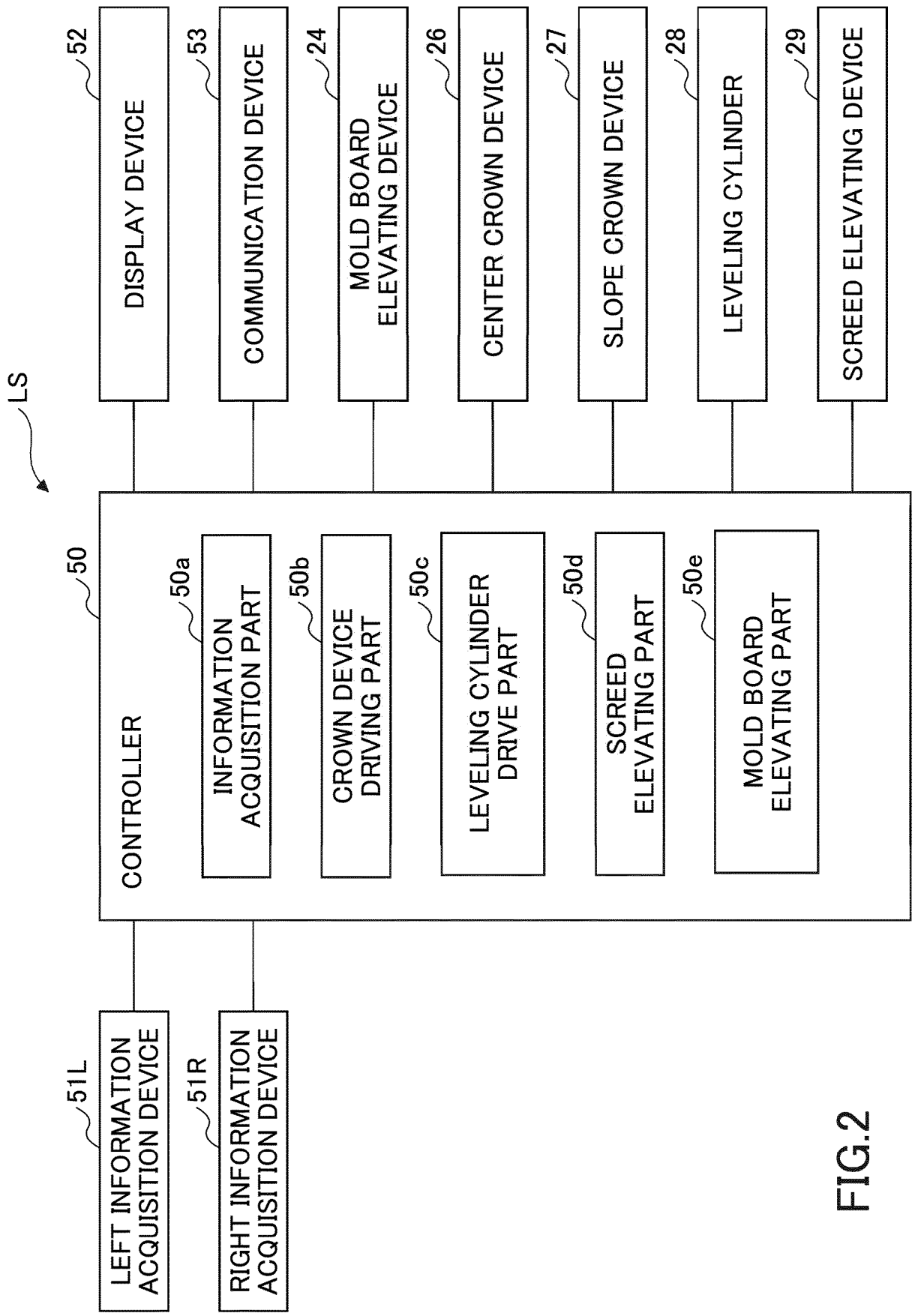

LS
52
DISPLAY DEVICE
53
COMMUNICATION DEVICE
24
MOLD BOARD ELEVATING DEVICE
26
CENTER CROWN DEVICE
27
SLOPE CROWN DEVICE
28
LEVELING CYLINDER
29
SCREED ELEVATING DEVICE
50
CONTROLLER
50a
INFORMATION ACQUISITION PART
50b
CROWN DEVICE DRIVING PART
50c
LEVELING CYLINDER DRIVE PART
50d
SCREED ELEVATING PART
50e
MOLD BOARD ELEVATING PART
51L
LEFT INFORMATION ACQUISITION DEVICE
51R
RIGHT INFORMATION ACQUISITION DEVICE

FIG.2

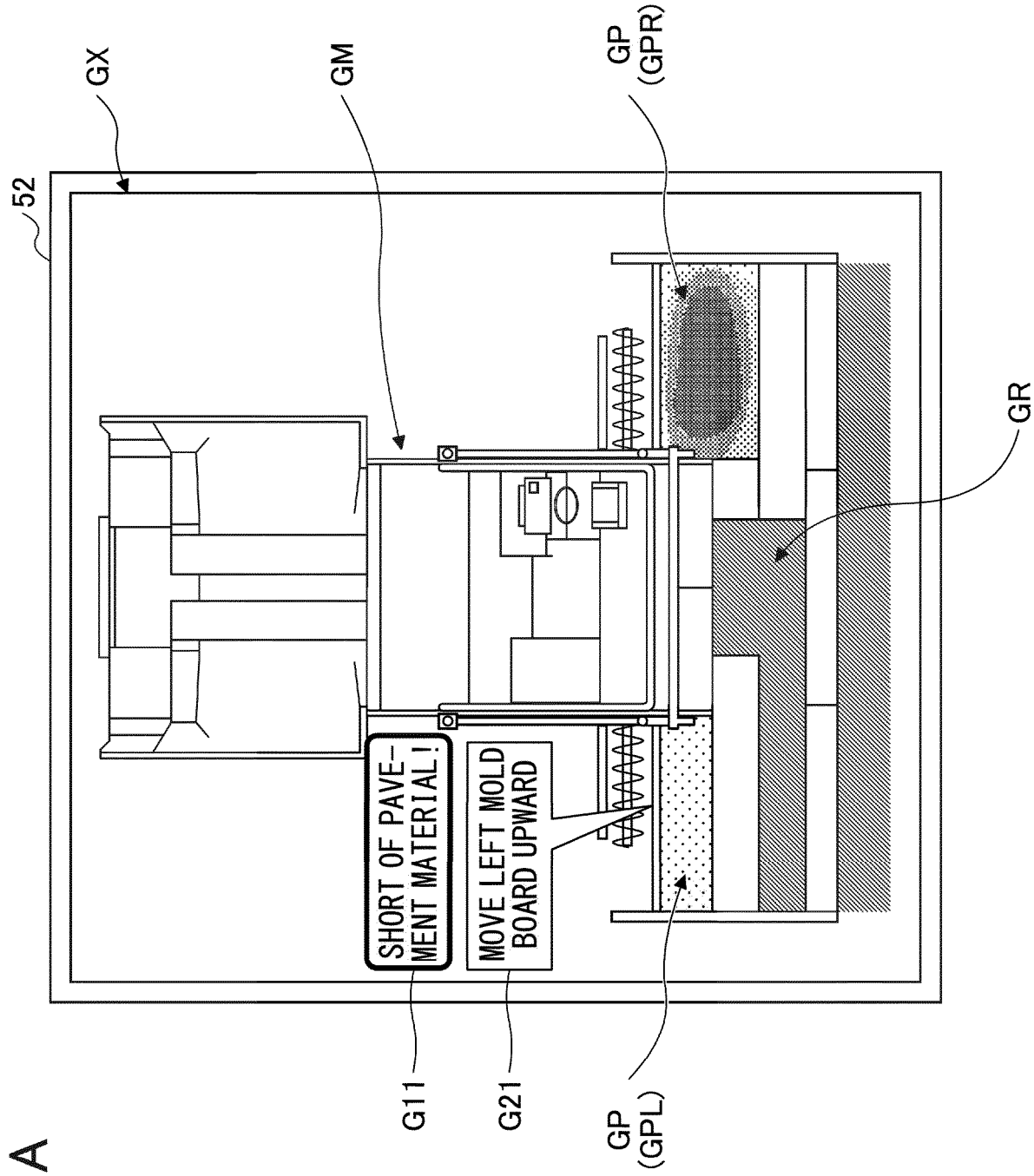

GX
GM
GP
(GPR)
52
GR
SHORT OF PAVE-
MENT MATERIAL !
MOVE LEFT MOLD
BOARD UPWARD
G11
G21
GP
(GPL)

FIG.3A

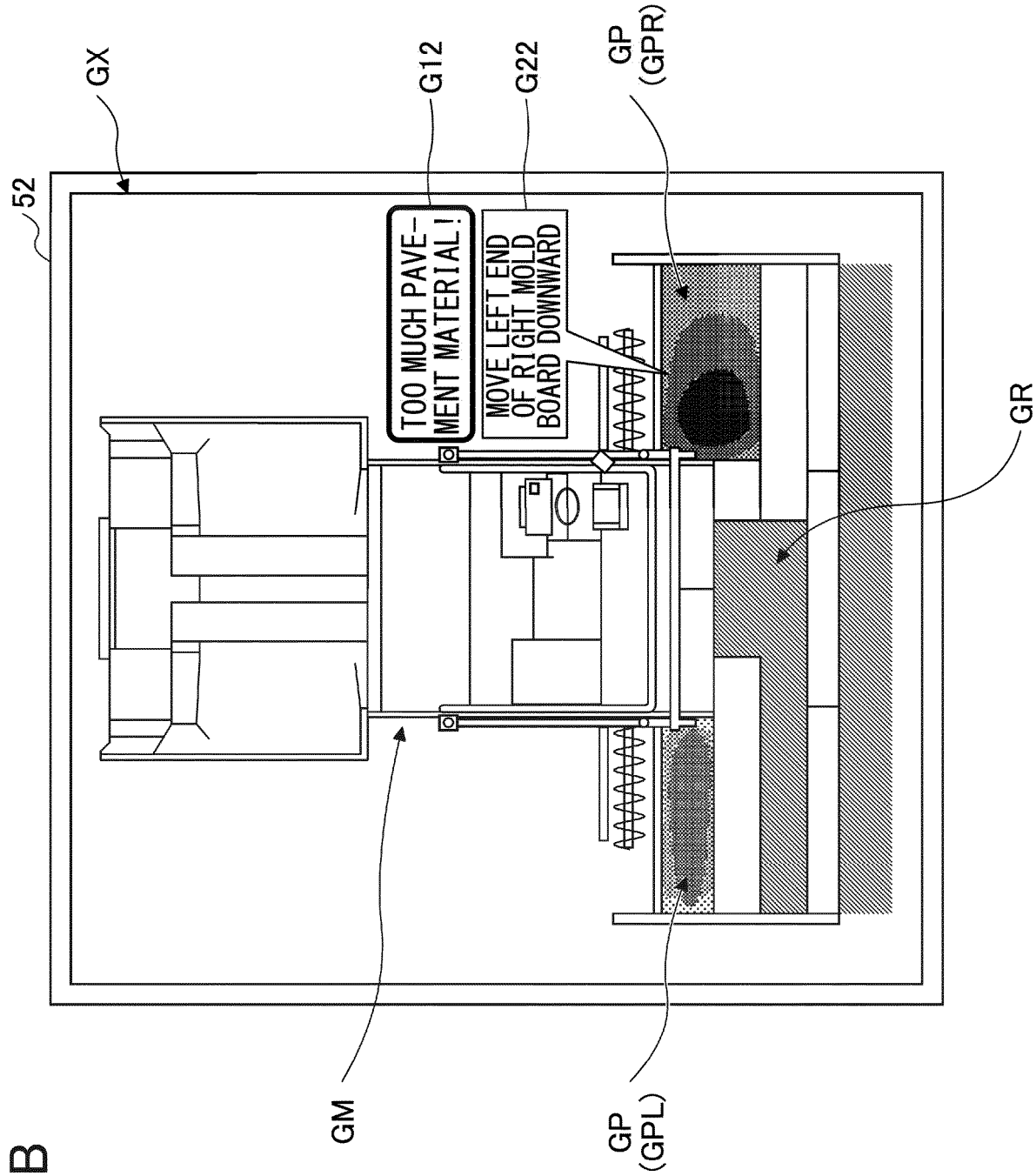
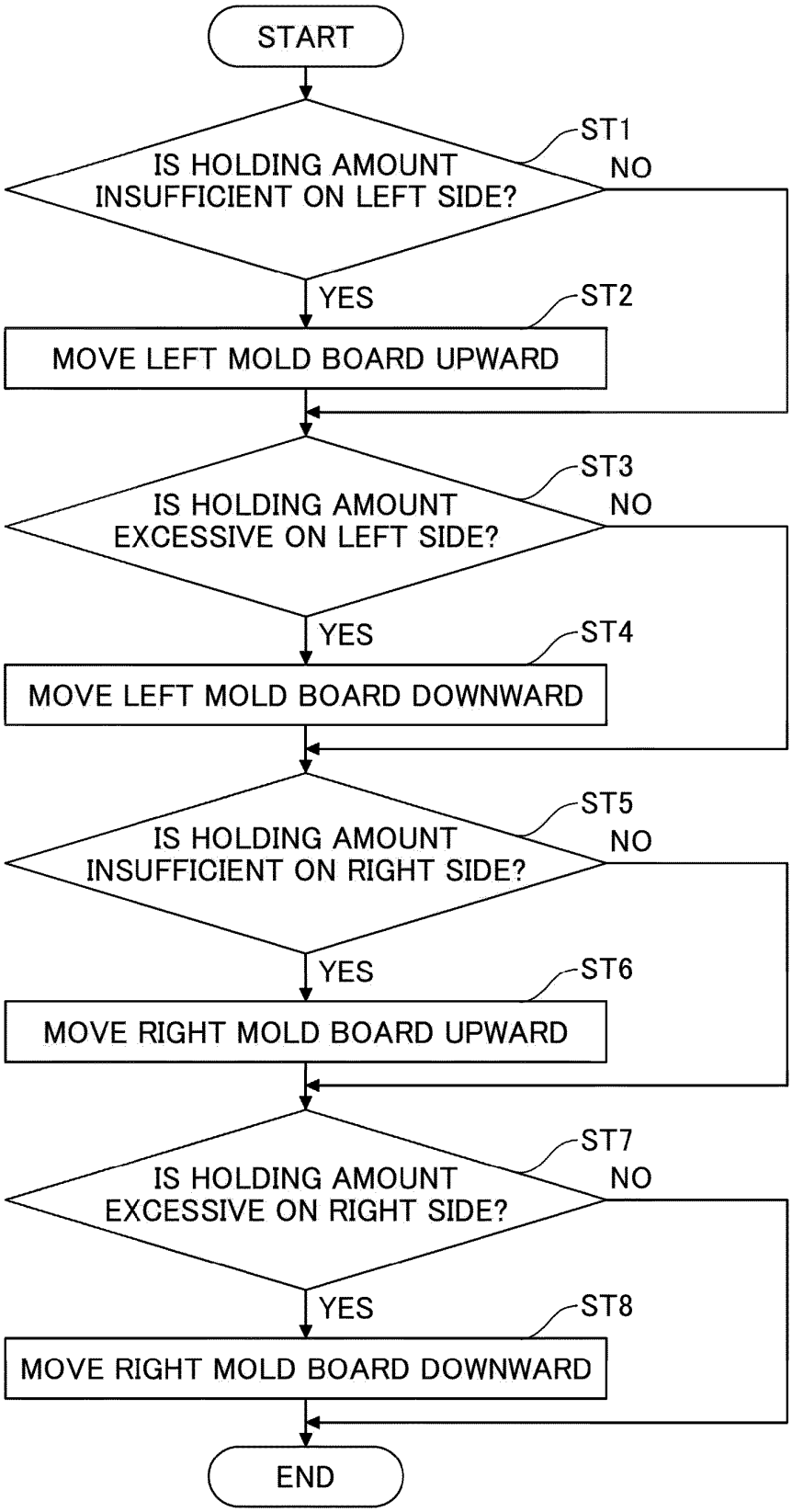

GX
52
G12
G22
GP
(GPR)
TOO MUCH PAVE-
MENT MATERIAL!
MOVE LEFT END
OF RIGHT MOLD
BOARD DOWNWARD
GR
GM
GP
(GPL)

FIG.3B

FIG.4


START
IS HOLDING AMOUNT INSUFFICIENT ON LEFT SIDE?
ST1
NO
YES
ST2
MOVE LEFT MOLD BOARD UPWARD
IS HOLDING AMOUNT EXCESSIVE ON LEFT SIDE?
ST3
NO
YES
ST4
MOVE LEFT MOLD BOARD DOWNWARD
IS HOLDING AMOUNT INSUFFICIENT ON RIGHT SIDE?
ST5
NO
YES
ST6
MOVE RIGHT MOLD BOARD UPWARD
IS HOLDING AMOUNT EXCESSIVE ON RIGHT SIDE?
ST7
NO
YES
ST8
MOVE RIGHT MOLD BOARD DOWNWARD
END

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2020/013111

A. CLASSIFICATION OF SUBJECT MATTER
E01C 19/48(2006.01)i
FI: E01C19/48 A

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
E01C19/48

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan	1922-1996
Published unexamined utility model applications of Japan	1971-2020
Registered utility model specifications of Japan	1996-2020
Published registered utility model applications of Japan	1994-2020

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	WO 2019/026830 A1 (SUMITOMO (S.H.I.) CONSTRUCTION MACHINERY COMPANY, LIMITED) 07.02.2019 (2019-02-07) paragraphs [0036]-[0038], fig. 1-5	1-3 4-6
Y A	JP 3713247 B2 (SUMITOMO CONSTRUCTION MACHINERY MANUFACTURING CO., LTD.) 09.11.2005 (2005-11-09) paragraphs [0012]-[0018], fig. 5, 6	1-3 4-6
A	WO 2019/031318 A1 (SUMITOMO (S.H.I.) CONSTRUCTION MACHINERY COMPANY, LIMITED) 14.02.2019 (2019-02-14) paragraphs [0018]-[0022], [0032], [0045]-[0047]	1-6
A	JP 2017-160636 A (SUMITOMO (S.H.I.) CONSTRUCTION MACHINERY COMPANY, LIMITED) 14.09.2017 (2017-09-14) entire text, all drawings	1-6
A	US 2012/0282026 A1 (ATHERTON) 08.11.2012 (2012-11-08) entire text, all drawings	1-6

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"I" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
01 June 2020 (01.06.2020)	16 June 2020 (16.06.2020)

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2020/013111

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
WO 2019/026830 A1	07 Feb. 2019	(Family: none)	
JP 3713247 B2	09 Nov. 2005	(Family: none)	
WO 2019/031318 A1	14 Feb. 2019	(Family: none)	
JP 2017-160636 A	14 Sep. 2017	(Family: none)	
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Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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- JP 2017160636 A **[0005]**
- JP 2019066400 A **[0100]**