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(71) Applicant: **Sumitomo Heavy Industries, Ltd.**
Tokyo 141-6025 (JP)

(72) Inventor: **ITOH, Takumi**
Kanagawa, 237-8555 (JP)

(74) Representative: **Louis Pöhlau Lohrentz**
Patentanwälte
Postfach 30 55
90014 Nürnberg (DE)

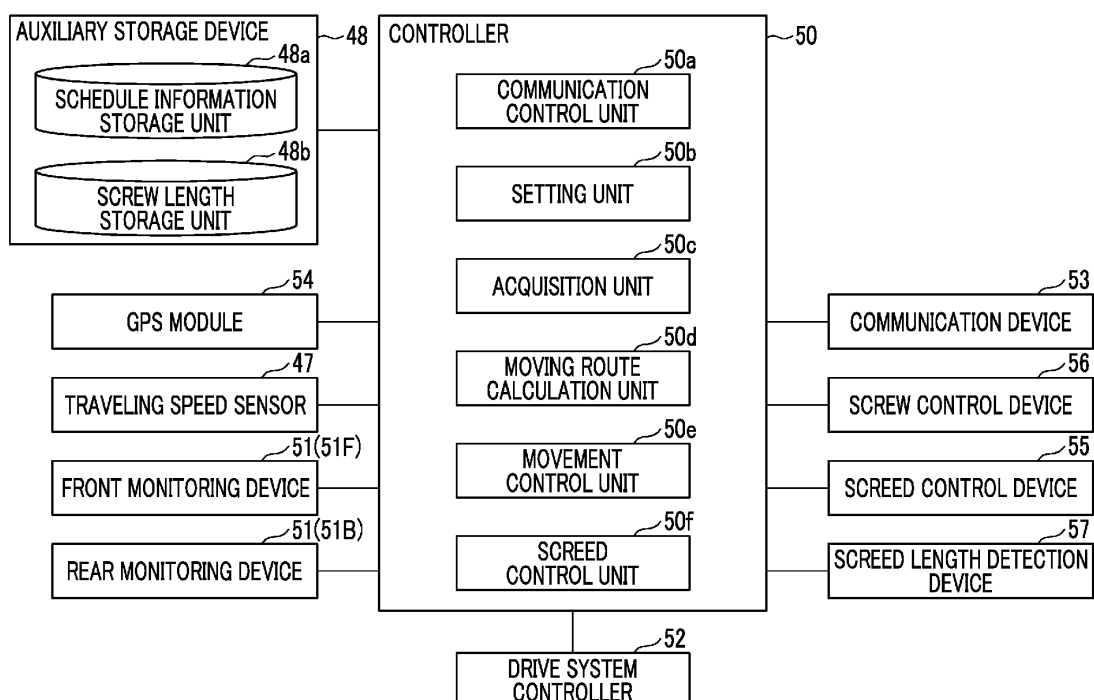
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(54) **ASPHALT FINISHER**

(57) Improvement of safety is realized. An asphalt finisher (100) includes a tractor (1), a hopper (2) that is provided on a front side of the tractor (1), a conveyor (CV) that transports a paving material in the hopper (2) to a rear side of the tractor (1), a screw (3) that spreads the paving material, which is transported by the conveyor (CV) and which is sprinkled to a road surface, in a vehicle width direction, and a screed device (31) that levels the

paving material spread by the screw (3) on a rear side of the screw (3) and that is capable of expanding and contracting in the vehicle width direction, in which expansion and contraction of the screed device (31) is configured to be controlled such that a length of the screed device (31) in the vehicle width direction does not fall below a predetermined length based on the screw (3).

FIG. 2



Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to an asphalt finisher.

Description of Related Art

[0002] In the related art, an asphalt finisher including a tractor, a hopper that is provided on a front side of the tractor and that receives a paving material, a conveyor that feeds the paving material in the hopper to a rear side of the tractor, a screw that spreads the paving material fed by the conveyor on the rear side of the tractor, and a screed that levels the paving material spread by the screw on a rear side of the screw is known.

[0003] When the asphalt finisher performs construction, a design drawing is prepared, and construction to level the paving material on a road surface is performed based on the design drawing. Various techniques in order to make the construction easy are proposed. For example, in Japanese Unexamined Patent Publication No. 2019-007336, a technique of automatically correcting the length of a screed in a vehicle width direction when automatically steering an asphalt finisher is proposed.

SUMMARY OF THE INVENTION

[0004] However, in the asphalt finisher, a side plate that extends forward is provided at a far end portion of the screed. For this reason, when the length of the screed in the vehicle width direction changes, there is a possibility in which the side plate comes into contact with a screw.

[0005] Such a possibility is not limited to a case where the length of the screed in the vehicle width direction is automatically corrected through automatic steering and exists also in a case where an operator adjusts the length of the screed in the vehicle width direction in the asphalt finisher.

[0006] In view of the above description, by performing control such that the length of the screed of the asphalt finisher in the vehicle width direction does not fall below a predetermined length, it is suppressed that the side plate comes into contact with the screw.

[0007] According to an aspect of the present invention, there is provided an asphalt finisher including a tractor, a hopper that is provided on a front side of the tractor, a conveyor that transports a paving material in the hopper to a rear side of the tractor, a screw that spreads the paving material, which is transported by the conveyor and which is sprinkled to a road surface, in a vehicle width direction, and a screed device that levels the paving material spread by the screw on a rear side of the screw and that is capable of expanding and contracting in the vehicle

width direction, in which expansion and contraction of the screed device is configured to be controlled such that a length of the screed device in the vehicle width direction does not fall below a predetermined length based on the screw.

[0008] According to the aspect of the present invention, by performing control such that the length of the screed of the asphalt finisher in the vehicle width direction does not fall below the predetermined length, it is suppressed that the side plate comes into contact with the screw, and improvement of safety is realized.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009]

Figs. 1A and 1B are views showing an asphalt finisher which is an example of a road machine according to an embodiment.

Fig. 2 is a block diagram showing a configuration example of a controller and devices connected to the controller according to the embodiment.

Fig. 3 is a hydraulic circuit diagram showing a configuration example of a hydraulic system mounted on the asphalt finisher according to the embodiment.

Fig. 4 is an explanatory view of a screw included in the asphalt finisher according to the embodiment.

Fig. 5 is a view showing a moving route of the asphalt finisher according to the embodiment based on schedule information.

Fig. 6 is a view showing a positional relationship between a left side plate and the screw according to the embodiment.

Fig. 7 is a flowchart showing control of the asphalt finisher performed by the controller according to the embodiment.

Fig. 8 is a rear view of an asphalt finisher according to a modification example.

DETAILED DESCRIPTION OF THE INVENTION

[0010] Hereinafter, an embodiment of the present invention will be described with reference to the drawings. In each of the drawings, the same or corresponding configurations will be assigned with the same reference symbols, and description thereof will be omitted.

[0011] Figs. 1A and 1B are schematic views of an asphalt finisher 100 according to an embodiment of the present invention. Specifically, Fig. 1A is a left side view of the asphalt finisher 100, and Fig. 1B is a top view of the asphalt finisher 100.

[0012] The asphalt finisher 100 is mainly configured by a tractor 1, a hopper 2, and a screed 3. In the example shown in Figs. 1A and 1B, the asphalt finisher 100 is disposed such that a vehicle length direction thereof corresponds to an X-axis direction and a vehicle width direction thereof corresponds to a Y-axis direction. In addition, a Z-axis is disposed to be perpendicular to each

of an X-axis and a Y-axis. Specifically, a front side in the vehicle length direction corresponds to a +X side, a rear side in the vehicle length direction corresponds to a -X side, a left side in the vehicle width direction corresponds to a +Y side, a right side in the vehicle width direction corresponds to a -Y side, an upper side in a vertical direction corresponds to a +Z side, and a lower side in the vertical direction corresponds to a -Z side.

[0013] The tractor 1 is a mechanism for causing the asphalt finisher 100 to travel. In the example shown in Figs. 1A and 1B, the tractor 1 rotates a rear wheel 5 using a rear wheel traveling motor 20 (see Fig. 3) and moves the asphalt finisher 100 by rotating a front wheel 6 using a front wheel traveling motor 22 (see Fig. 3). Both of the rear wheel traveling motor 20 and the front wheel traveling motor 22 are hydraulic motors that rotate by receiving supply of a hydraulic oil from a hydraulic pump. However, the tractor 1 may include a crawler instead of the wheels.

[0014] The hopper 2 is a mechanism for receiving a paving material. The paving material is, for example, an asphalt mixture or the like. In the example shown in Figs. 1A and 1B, the hopper 2 is provided on the front side (+X side) of the tractor 1 and is configured to be opened and closed in the Y-axis direction (vehicle width direction) by a hopper cylinder 24. The asphalt finisher 100 usually brings the hopper 2 into a fully open state so that a paving material is received from a loading platform of a dump truck. In addition, the asphalt finisher 100 continues to travel while pushing the dump truck forward via a push roller 2b even when receiving the paving material from the loading platform of the dump truck. Figs. 1A and 1B show the asphalt finisher 100 when the hopper 2 is in a fully open state. An operator of the asphalt finisher 100 closes the hopper 2 when the paving material in the hopper 2 decreases and collects the paving material near an inner wall of the hopper 2 at a central portion of the hopper 2. This is because a conveyor CV which is at the bottom of the central portion of the hopper 2 can transport the paving material to the rear side of the tractor 1. The paving material transported to the rear side (-X side) of the tractor 1 is spread in the vehicle width direction on the rear side of the tractor 1 and the front side of the screed 3 by a screw SC.

[0015] The conveyor CV is driven by a hydraulic motor that rotates by receiving supply of the hydraulic oil from a hydraulic pump. In the example shown in Figs. 1A and 1B, the conveyor CV is configured to send a paving material in the hopper 2 to the rear side of the tractor 1 via a transport passage CP. The transport passage CP is a substantially rectangular parallelepiped space formed inside the tractor 1 and has a substantially rectangular inlet OP that opens into the hopper 2 in a front surface of the tractor 1. Specifically, the conveyor CV includes a left conveyor and a right conveyor.

[0016] The screw SC is driven by a hydraulic motor that rotates by receiving supply of a hydraulic oil from the hydraulic pump. Specifically, the screw SC includes a left

main screw SCLM, a right main screw SCRM, a first left extension screw SCLE1, and a first right extension screw SCRE1. The left conveyor is configured to send a paving material toward the left main screw SCLM. The right conveyor is configured to send the paving material toward the right main screw SCRM. The left main screw SCLM and the right main screw SCRM are disposed within the width of the tractor 1. The first left extension screw SCLE1 is connected to a left end of the left main screw SCLM and is disposed to protrude from the width of the tractor 1 to the left side. The first right extension screw SCRE1 is connected to a right end of the right main screw SCRM and is disposed to protrude from the width of the tractor 1 to the right side.

[0017] The screed 3 is a mechanism for leveling a paving material. In the example shown in Figs. 1A and 1B, the screed 3 mainly includes a main screed 30 and a telescopic screed 31. The main screed 30 includes a left main screed and a right main screed. The telescopic screed 31 includes a left telescopic screed 31L and a right telescopic screed 31R. The main screed 30, the left telescopic screed 31L, and the right telescopic screed 31R are disposed to be shifted away from each other on the front and rear sides so as not to overlap each other in the vehicle length direction. Specifically, the left telescopic screed 31L is disposed on the rear side of the main screed 30, and the right telescopic screed 31R is disposed on the rear side of the left telescopic screed 31L. The screed 3 is a floating screed pulled 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 in response to expansion and contraction of a screed lift cylinder 25. The leveling arm 3A includes a left leveling arm 3AL and a right leveling arm 3AR.

[0018] The telescopic screed 31 is configured to be capable of expanding and contracting in the vehicle width direction by a screed expanding and contracting cylinder 27. The screed expanding and contracting cylinder 27 is supported by a support portion fixed to a rear surface of a casing of the main screed 30 and is configured to be capable of expanding and contracting the telescopic screed 31 in the vehicle width direction (Y-axis direction). Specifically, the screed expanding and contracting cylinder 27 includes a left screed expanding and contracting cylinder 27L and a right screed expanding and contracting cylinder 27R. The left screed expanding and contracting cylinder 27L can expand and contract the left telescopic screed 31L to the left side in the vehicle width direction with respect to the main screed 30. The right screed expanding and contracting cylinder 27R can expand and contract the right telescopic screed 31R to the right side in the vehicle width direction with respect to the main screed 30.

[0019] The leveling arm 3A is configured to be capable of connecting the screed 3 to the tractor 1. Specifically, one end of the leveling arm 3A is connected to the screed 3 and the other end thereof is pivotably connected to the tractor 1.

[0020] A leveling cylinder 23 is a hydraulic cylinder that moves a front end portion of the leveling arm 3A up and down in order to adjust a leveling thickness (pavement thickness) of a paving material. In the example shown in Figs. 1A and 1B, a cylinder portion of the leveling cylinder 23 is connected to the tractor 1, and a rod portion thereof is connected to the front end portion of the leveling arm 3A. The front end portion of the leveling arm 3A is slidably supported by the tractor 1. In a case of increasing the pavement thickness, a controller 50 causes a hydraulic oil discharged by the hydraulic pump to flow into a rod-side oil chamber of the leveling cylinder 23 and contracts the leveling cylinder 23 to raise the front end portion of the leveling arm 3A. On the other hand, in a case of reducing the leveling thickness, the controller 50 causes a hydraulic oil in the rod-side oil chamber of the leveling cylinder 23 to flow out and expands the leveling cylinder 23 to lower the front end portion of the leveling arm 3A.

[0021] The screed lift cylinder 25 is a hydraulic cylinder for lifting the screed 3. In the example shown in Figs. 1A and 1B, a cylinder portion of the screed lift cylinder 25 is connected to the tractor 1, and a rod portion thereof is connected to a rear end portion of the leveling arm 3A. In a case of lifting the screed 3, the controller 50 causes the hydraulic oil discharged by the hydraulic pump to flow into a rod-side oil chamber of the screed lift cylinder 25. As a result, the screed lift cylinder 25 contracts, the rear end portion of the leveling arm 3A is lifted, and the screed 3 is lifted. On the other hand, in a case of lowering the lifted screed 3, the controller 50 enables the hydraulic oil in the rod-side oil chamber of the screed lift cylinder 25 to flow out. As a result, the screed lift cylinder 25 is expanded by the weight of the screed 3, the rear end portion of the leveling arm 3A is lowered, and the screed 3 is lowered.

[0022] A side plate 40 is attached to a distal end of the telescopic screed 31. The side plate 40 includes a left side plate 40L and a right side plate 40R. Specifically, the left side plate 40L is attached to a distal end (left end) of the left telescopic screed 31L, and the right side plate 40R is attached to a distal end (right end) of the right telescopic screed 31R.

[0023] As shown in Fig. 1B, an end portion of the side plate 40 on a front side (X-axis positive direction side) in a traveling direction extends to an extension line of the screw SC in a longitudinal direction (rotation axis direction).

[0024] The side plate 40 is also attached to a distal end of a telescopic mold board 41. The telescopic mold board 41 is a member for adjusting the amount of paving material staying in front of the telescopic screed 31, out of a paving material spread by the screw SC, and is configured to be capable of expanding and contracting in the vehicle width direction together with the telescopic screed 31.

[0025] Specifically, the telescopic mold board 41 is a plate-shaped member extending in the vehicle width direction and includes a left telescopic mold board 41L and

a right telescopic mold board 41R. In addition, the left side plate 40L (an example of a plate portion) is attached to a distal end (left end) of the left telescopic mold board 41L, and the right side plate 40R (an example of the plate portion) is attached to a distal end (right end) of the right telescopic mold board 41R.

[0026] The telescopic mold board 41 is configured to be capable of adjusting a height in a Z-axis direction regardless of the telescopic screed 31 and the side plate 40. By moving the telescopic mold board 41 up and down to adjust the size of a gap between a lower end of the telescopic mold board 41 and a roadbed, the asphalt finisher 100 can adjust the amount of paving material passing through the gap. For this reason, by moving the telescopic mold board 41 up and down, the asphalt finisher 100 can adjust the amount (height) of paving material staying on the rear side (-X side) of the telescopic mold board 41 and the front side (+X side) of the telescopic screed 31 and can adjust the amount of paving material taken into the lower side of the telescopic screed 31.

[0027] A screed step 42 is a member configuring a scaffold when a worker works behind the screed 3. Specifically, the screed step 42 includes a left screed step 42L, a central screed step 42C, and a right screed step 42R.

[0028] A retaining plate 43 is a plate-shaped member for preventing a paving material sent out in the vehicle width direction by the screw SC from being scattered in front of the screw SC in order to appropriately send out the paving material in the vehicle width direction by the screw SC. In the example shown in Figs. 1A and 1B, the retaining plate 43 includes a left retaining plate 43L and a right retaining plate 43R.

[0029] The controller 50 is a control device that controls the asphalt finisher 100. In the example shown in Figs. 1A and 1B, the controller 50 is a computer including a CPU, a volatile storage device, and a non-volatile storage device and is mounted on the tractor 1. Various types of functions of the controller 50 are realized, for example, as the CPU executes a program stored in the non-volatile storage device. In addition, the various types of functions realized by the controller 50 include, for example, a function of controlling a discharge amount of the hydraulic pump that supplies a hydraulic oil for driving a hydraulic actuator and a function of controlling a flow of the hydraulic oil between the hydraulic actuator and the hydraulic pump. The hydraulic actuator includes a hydraulic cylinder and a hydraulic motor.

[0030] A communication device 53 is configured to be capable of controlling communication between the asphalt finisher 100 and a device outside the asphalt finisher 100. The communication device 53 according to the present embodiment is provided in front of a driver's seat 1S and controls communication via a mobile phone communication network, a short-range wireless communication network, a satellite communication network, or the like.

[0031] AGPS module 54 is an example of a global nav-

igation satellite system (GNSS) module and receives position information indicating a two-dimensional positioning result through the global positioning system (GPS). The position information is information representing the position of the asphalt finisher 100 in latitude and longitude. Although the GPS is used as a position information acquisition method in the present embodiment, the position information acquisition method is not limited, and other known methods may be used.

[0032] A space recognition device 51 is attached to the tractor 1. The space recognition device 51 acquires information related to a space around the asphalt finisher 100 and is configured to be capable of outputting the acquired information to the controller 50. The space recognition device 51 according to the present embodiment includes a front monitoring device 51F and a rear monitoring device 51B.

[0033] The front monitoring device 51F is configured to be capable of monitoring the front of the asphalt finisher 100. In the present embodiment, the front monitoring device 51F is a LIDAR, of which a monitoring range RF is a space in front of the tractor 1, and is attached to a front end central portion of an upper surface of the tractor 1. The front monitoring device 51F may be attached to other parts of the asphalt finisher 100.

[0034] The rear monitoring device 51B is configured to be capable of monitoring the rear of the asphalt finisher 100. In the present embodiment, the rear monitoring device 51B is a LIDAR, of which a monitoring range RB is a space behind the screed 3, and is attached to a guide rail 1G that functions as a handrail for the operator of the asphalt finisher 100. The rear monitoring device 51B may be attached to a lower portion of the driver's seat 1S or may be attached to other parts of the asphalt finisher 100.

[0035] The space recognition device 51 may include a side monitoring device configured to be capable of monitoring the side of the asphalt finisher 100. In this case, the side monitoring device may be attached to a left end portion of the upper surface of the tractor 1 on the front side of the rear wheel 5, for example, as a LIDAR of which a monitoring range is a space to the left of the tractor 1. The side monitoring device may be attached to a right end portion of the upper surface of the tractor 1 on the front side of the rear wheel 5, for example, as a LIDAR of which a monitoring range is a space to the right of the tractor 1.

[0036] The LIDAR measures, for example, a distance between a million or more points within the monitoring range and the LIDAR. However, at least one of the front monitoring device 51F and the rear monitoring device 51B may be a monocular camera, a stereo camera, a millimeter wave radar, a laser radar, a laser scanner, a distance image camera, a laser range finder, or the like. The same applies to the side monitoring device. An example in which the LIDAR is used as an example of the space recognition device 51 has been described in the embodiment. However, the present embodiment does not limit the space recognition device 51 to the LIDAR.

That is, a space recognition device that can recognize a space based on the asphalt finisher 100 may be used.

[0037] The monitoring range RF of the front monitoring device 51F includes a roadbed. The same applies to the monitoring range of the side monitoring device. In the present embodiment, the monitoring range RF has a width larger than the width of a roadbed BS.

[0038] The monitoring range RB of the rear monitoring device 51B includes a newly constructed pavement body. In the present embodiment, the monitoring range RB has a width larger than the width of the newly constructed pavement body.

[0039] Measurement information detected by the space recognition device 51 according to the present embodiment is transmitted to the controller 50. The controller 50 according to the present embodiment automatically steers the asphalt finisher 100 based on the received measurement information. In addition, the controller 50 may perform notification, such as warning, for a driver based on the received measurement information.

[0040] Next, the controller 50 mounted on the asphalt finisher 100 will be described with reference to Fig. 2. Fig. 2 is a block diagram showing a configuration example of the controller 50 and devices connected to the controller 50.

[0041] As shown in Fig. 2, the controller 50 is connected to a traveling speed sensor 47, an auxiliary storage device 48, the GPS module 54, the front monitoring device 51F, the rear monitoring device 51B, a drive system controller 52, the communication device 53, a screed control device 55, a screw control device 56, and a screed length detection device 57.

[0042] The traveling speed sensor 47 is configured to detect a traveling speed of the asphalt finisher 100. In the example shown in Fig. 2, the traveling speed sensor 47 is an encoder that detects an angular speed of a rotation axis of the rear wheel traveling motor 20 which drives the rear wheel 5. Specifically, the traveling speed sensor 47 includes a left traveling speed sensor and a right traveling speed sensor. The left traveling speed sensor is an encoder that detects an angular speed of a rotation axis of a left rear wheel traveling motor 20L which drives a left rear wheel. The right traveling speed sensor is an encoder that detects an angular speed of a rotation axis of a right rear wheel traveling motor 20R which drives a right rear wheel. The traveling speed sensor 47 may be configured by a proximity switch or the like that detects a slit formed in a rotating plate.

[0043] The auxiliary storage device 48 is configured to store various types of information. In the example shown in Fig. 2, the auxiliary storage device 48 is a non-volatile storage device mounted on the tractor 1 and stores various types of information. For example, the auxiliary storage device 48 includes a schedule information storage unit 48a and a screw length storage unit 48b.

[0044] The schedule information storage unit 48a stores schedule information for constructing a road surface which is a pavement target of the asphalt finisher

100. The schedule information according to the present embodiment includes, for example, a center line of a route through which the asphalt finisher 100 moves and a target line indicating an end portion (a portion that is a boundary between the road surface and a road shoulder) of the road surface to be paved. The asphalt finisher 100 according to the present embodiment automatically controls pavement of a road based on the schedule information.

[0045] The screw length storage unit 48b stores information of the length of the screw SC included in the asphalt finisher 100. The screw length storage unit 48b according to the present embodiment stores information related to the length of the screw SC after being connected, for example, in a case where an extended screw (for example, the first left extension screw SCLE1 or the first right extension screw SCRE1) is connected to a main screw (the left main screw SCLM or the right main screw SCRM) in the asphalt finisher 100.

[0046] Further, the screw length storage unit 48b may have information related to the extended screw that is attachable to the asphalt finisher 100. For example, the screw length storage unit 48b may store the length of the main screw (the left main screw SCLM or the right main screw SCRM) provided at the asphalt finisher 100. Further, the screw length storage unit 48b may associate information for identifying the extended screw (for example, a model number, RFID, or a two-dimensional bar code) and the length of the extended screw with each other for each extended screw connectable to the asphalt finisher 100.

[0047] Therefore, in a case where the extended screw is connected to the asphalt finisher 100, the controller 50 can recognize the length of the screw SC of the asphalt finisher 100 from information stored in the screw length storage unit 48b. In addition, the association relationship is not limited to a method of storing in the auxiliary storage device 48 and may be held by a server that can communicate with the asphalt finisher 100.

[0048] The GPS module 54 is an example of the global navigation satellite system (GNSS) module and receives position information indicating a two-dimensional positioning result through the global positioning system (GPS). The position information is information representing the position of the asphalt finisher 100 in latitude and longitude. Although the GPS is used as a position information acquisition method in the present embodiment, the position information acquisition method is not limited, and other known methods may be used.

[0049] The screed length detection device 57 measures a length by which the telescopic screed 31 expands and contracts in the vehicle width direction. The screed length detection device 57 may use any sensor insofar as the length by which the telescopic screed 31 expands and contracts in the vehicle width direction can be measured, or for example, an imaging device may be used. In a case where the imaging device is used, the telescopic screed 31 is imaged, and the length of the telescopic

screed 31 in the vehicle width direction is identified from the captured image.

[0050] The communication device 53 performs wireless communication with devices in the surroundings of the asphalt finisher 100, for example, a load roller, a mobile communication device, an RFID reader, or the like. In the present embodiment, for example, any one or more of Wi-Fi (registered trademark), wireless LAN, Bluetooth (registered trademark), and the like may be used as wireless communication standards of the communication device 53.

[0051] The drive system controller 52 controls the tractor 1 in accordance with a control command. For example, the drive system controller 52 performs speed control and steering angle control of the tractor 1.

[0052] The screed control device 55 is configured to control an expansion and contraction amount of the telescopic screed 31. In the example shown in Fig. 2, the screed control device 55 controls the flow rate of a hydraulic oil flowing into the screed expanding and contracting cylinder 27. The screed control device 55 includes a screed expansion and contraction control valve 37 shown in Fig. 3 and switches between communication and cutoff of a pipeline that connects the inside of a rod-side oil chamber of the screed expanding and contracting cylinder 27 and the hydraulic pump to each other in accordance with a control command from the controller 50.

[0053] Then, the screed control device 55 performs, in accordance with the control command from the controller 50, control of shrinking the left telescopic screed 31L by contracting the screed expanding and contracting cylinder 27 and control of extending the left telescopic screed 31L by expanding the screed expanding and contracting cylinder 27.

[0054] The screw control device 56 is configured to control the rotation speed of the screw SC. In the example shown in Fig. 2, the screw control device 56 is an electromagnetic valve that controls the flow rate of a hydraulic oil flowing into the hydraulic motor driving the screw SC. Specifically, the screw control device 56 increases and decreases a flow path area of a pipeline that connects the hydraulic motor driving the screw SC and the hydraulic pump to each other in accordance with the control command from the controller 50. More specifically, the screw control device 56 increases the flow rate of the hydraulic oil flowing into the hydraulic motor driving the screw SC and increases the rotation speed of the screw SC by increasing the flow path area. Alternatively, the screw control device 56 decreases the flow rate of the hydraulic oil flowing into the hydraulic motor driving the screw SC and decreases the rotation speed of the screw SC by reducing the flow path area.

[0055] The controller 50 acquires information from the GPS module 54, the front monitoring device 51F, the rear monitoring device 51B, the traveling speed sensor 47, the screed length detection device 57, and the auxiliary storage device 48, after executing various types of calculation, and outputs a control command to the screed

control device 55, the screw control device 56, and the drive system controller 52 in accordance with the calculation results. Functional blocks included in the controller 50 according to the present embodiment will be described later.

<Description of Hydraulic System>

[0056] Next, a hydraulic system mounted on the asphalt finisher 100 will be described with reference to Fig. 3. Fig. 3 is a hydraulic circuit diagram showing a configuration example of the hydraulic system mounted on the asphalt finisher 100.

[0057] The hydraulic system mainly includes a hydraulic source 14, a rear wheel drive unit F1, a conveyor and screw drive unit F2, a front wheel drive unit F3, a steering and compacting device drive unit F4, a leveling unit F5, a hopper drive unit F6, a screed lift unit F7, and a screed expansion and contraction unit F8.

[0058] The hydraulic source 14 is configured to supply a hydraulic oil for operating various types of drive units. In the present embodiment, the hydraulic source 14 mainly includes an engine 14E, a rear wheel traveling pump 14R, a charge pump 14C, a cylinder pump 14M, a conveyor and screw pump 14S, and a front wheel traveling pump 14F.

[0059] The engine 14E is a drive source that drives the rear wheel traveling pump 14R, the charge pump 14C, the cylinder pump 14M, the conveyor and screw pump 14S, and the front wheel traveling pump 14F.

[0060] The rear wheel traveling pump 14R is a variable capacity type hydraulic pump that supplies a driving hydraulic oil to the rear wheel drive unit F1. In the present embodiment, the rear wheel traveling pump 14R is a swash plate variable capacity type bidirectional hydraulic pump used in a closed circuit.

[0061] The charge pump 14C is a fixed capacity type hydraulic pump that supplies a controlling hydraulic oil to the rear wheel drive unit F1.

[0062] The cylinder pump 14M is a variable capacity type hydraulic pump that can supply a hydraulic oil to each of the steering and compacting device drive unit F4, the leveling unit F5, the hopper drive unit F6, the screed lift unit F7, and the screed expansion and contraction unit F8. In the present embodiment, the cylinder pump 14M is a swash plate variable capacity type hydraulic pump, and a discharge amount thereof is controlled such that a discharge pressure becomes constant at a predetermined pressure.

[0063] The conveyor and screw pump 14S is a variable capacity type hydraulic pump that supplies a hydraulic oil to the conveyor and screw drive unit F2. In the present embodiment, the conveyor and screw pump 14S is a swash plate variable capacity type hydraulic pump.

[0064] The front wheel traveling pump 14F is a variable capacity type hydraulic pump that supplies a hydraulic oil to the front wheel drive unit F3. In the present embodiment, the front wheel traveling pump 14F is a swash

plate variable capacity type hydraulic pump.

[0065] The rear wheel drive unit F1 is configured to be capable of driving the rear wheel 5. In the present embodiment, the rear wheel drive unit F1 includes the left rear wheel traveling motor 20L, the right rear wheel traveling motor 20R, check valves 20La and 20Ra, relief valves 20Lb and 20Rb, and a speed reducer switching valve V0.

[0066] The left rear wheel traveling motor 20L is a hydraulic motor that drives a rear wheel on the left side. In addition, the right rear wheel traveling motor 20R is a hydraulic motor that drives a rear wheel on the right side. In the present embodiment, the left rear wheel traveling motor 20L and the right rear wheel traveling motor 20R are stepless speed change type hydraulic motors and configure a closed circuit (HST circuit) together with the rear wheel traveling pump 14R.

[0067] The check valve 20La maintains the pressure of a hydraulic oil in a pipeline C1 that connects a first port of the rear wheel traveling pump 14R and a second port of each of the left rear wheel traveling motor 20L and the right rear wheel traveling motor 20R to each other at a predetermined pressure or higher. Specifically, in a case where the pressure of the hydraulic oil in the pipeline C1 falls below the discharge pressure of the charge pump 14C, the check valve 20La causes the hydraulic oil discharged by the charge pump 14C to flow into the pipeline C1. Numbers in parentheses in the drawings represent port numbers. Similarly, the check valve 20Ra maintains the pressure of a hydraulic oil in a pipeline C2 that connects a second port of the rear wheel traveling pump 14R and a first port of each of the left rear wheel traveling motor 20L and the right rear wheel traveling motor 20R to each other at a predetermined pressure or higher. Specifically, in a case where the pressure of the hydraulic oil in the pipeline C2 falls below the discharge pressure of the charge pump 14C, the check valve 20Ra causes the hydraulic oil discharged by the charge pump 14C to flow into the pipeline C2.

[0068] The relief valve 20Lb maintains the pressure of a hydraulic oil in the pipeline C1 at a predetermined relief pressure or lower. Specifically, the relief valve 20Lb causes the hydraulic oil in the pipeline C1 to flow out of the closed circuit in a case where the pressure of the hydraulic oil in the pipeline C1 exceeds the relief pressure. Similarly, the relief valve 20Rb maintains the pressure of a hydraulic oil in the pipeline C2 at a predetermined relief pressure or lower. Specifically, the relief valve 20Rb causes the hydraulic oil in the pipeline C2 to flow out of the closed circuit in a case where the pressure of the hydraulic oil in the pipeline C2 exceeds the relief pressure.

[0069] The speed reducer switching valve V0 is a mechanism that switches between respective reduction ratios of the left rear wheel traveling motor 20L and the right rear wheel traveling motor 20R. In the present embodiment, the speed reducer switching valve V0 switches between the respective reduction ratios of the left rear

wheel traveling motor 20L and the right rear wheel traveling motor 20R using a hydraulic oil discharged by the charge pump 14C, in accordance with a control command from the controller 50.

[0070] The conveyor and screw drive unit F2 is configured to be capable of driving the conveyor CV and the screw SC. In the present embodiment, the conveyor and screw drive unit F2 mainly includes a conveyor motor 21C, a screw motor 21S, a conveyor control valve V1C, and a screw control valve V1S.

[0071] Both of the conveyor motor 21C and the screw motor 21S are variable capacity type hydraulic motors that form an open circuit. The conveyor motor 21C includes a left conveyor motor 21CL and a right conveyor motor 21CR. The screw motor 21S includes a left screw motor 21SL and a right screw motor 21SR. The conveyor control valve V1C includes a left conveyor control valve V1CL and a right conveyor control valve V1CR. The screw control valve V1S includes a left screw control valve V1SL and a right screw control valve V1SR.

[0072] The left conveyor control valve V1CL operates in accordance with a control command from the controller 50, causes a hydraulic oil discharged by the conveyor and screw pump 14S to flow into a suction port of the left conveyor motor 21CL, and causes a hydraulic oil flowing out from a discharge port of the left conveyor motor 21CL to be discharged to a hydraulic oil tank T. The right conveyor control valve V1CR operates in accordance with a control command from the controller 50, causes a hydraulic oil discharged by the conveyor and screw pump 14S to flow into a suction port of the right conveyor motor 21CR, and causes a hydraulic oil flowing out from a discharge port of the right conveyor motor 21CR to be discharged to the hydraulic oil tank T. Similarly, the left screw control valve V1SL operates in accordance with a control command from the controller 50, causes a hydraulic oil discharged by the conveyor and screw pump 14S to flow into a suction port of the left screw motor 21SL, and causes a hydraulic oil flowing out from a discharge port of the left screw motor 21SL to be discharged to the hydraulic oil tank T. The right screw control valve V1SR operates in accordance with a control command from the controller 50, causes a hydraulic oil discharged by the conveyor and screw pump 14S to flow into a suction port of the right screw motor 21SR, and causes a hydraulic oil flowing out from a discharge port of the right screw motor 21SR to be discharged to the hydraulic oil tank T. The hydraulic oil flowing out from the discharge port of each of the left conveyor motor 21CL, the right conveyor motor 21CR, the left screw motor 21SL, and the right screw motor 21SR is discharged to the hydraulic oil tank T through an oil cooler OC.

[0073] The front wheel drive unit F3 is configured to be capable of driving the front wheel 6. In the present embodiment, the front wheel drive unit F3 mainly includes the front wheel traveling motor 22 and a front wheel traveling valve V2.

[0074] The front wheel traveling motor 22 is a fixed

capacity type hydraulic motor that forms an open circuit. The front wheel traveling valve V2 operates in accordance with a control command from the controller 50 and causes a hydraulic oil discharged by the front wheel traveling pump 14F to flow into a suction port of the front wheel traveling motor 22. In the example shown in Fig. 3, the front wheel traveling motor 22 includes a left front wheel traveling motor 22L and a right front wheel traveling motor 22R. The front wheel traveling pump 14F supplies a hydraulic oil to each of the left front wheel traveling motor 22L and the right front wheel traveling motor 22R in parallel.

[0075] The steering and compacting device drive unit F4 is configured to be capable of driving a steering device and a compacting device (neither of which is shown). The steering device is a hydraulic device for steering the front wheel 6. In the present embodiment, the steering device changes, for example, the steering angle of the front wheel 6 using a hydraulic oil discharged by the cylinder pump 14M in response to an operation of a steering wheel by the operator. In addition, the compacting device is a hydraulic device for compacting a paving material. In the present embodiment, the compacting device includes a tamper and a vibrator and operates the tamper and the vibrator using the hydraulic oil discharged by the cylinder pump 14M.

[0076] The leveling unit F5 is configured to be capable of adjusting a pavement thickness. In the present embodiment, the leveling unit F5 mainly includes the leveling cylinder 23, a leveling control valve 33, and a pilot check valve 33P.

[0077] The leveling cylinder 23 is a hydraulic cylinder that moves the leveling arm 3A up and down in order to adjust a pavement thickness. The leveling cylinder 23 is configured to contract when increasing the pavement thickness and to expand when reducing the pavement thickness. In the example shown in Fig. 3, the leveling cylinder 23 includes a left leveling cylinder 23L and a right leveling cylinder 23R.

[0078] The leveling control valve 33 is configured to operate in accordance with a control signal from the controller 50. In the example shown in Fig. 3, the leveling control valve 33 includes a left leveling control valve 33L and a right leveling control valve 33R. In a case of increasing a pavement thickness, the left leveling control valve 33L causes a hydraulic oil discharged by the cylinder pump 14M to flow into a rod-side oil chamber of the left leveling cylinder 23L and causes a hydraulic oil flowing out from a head-side oil chamber of the left leveling cylinder 23L to be discharged to the hydraulic oil tank T. In this case, the left leveling cylinder 23L contracts, and the left leveling arm 3AL rises. The same applies to the right leveling control valve 33R that contracts the right leveling cylinder 23R. On the other hand, in a case of reducing the pavement thickness, the left leveling control valve 33L causes a hydraulic oil discharged by the cylinder pump 14M to flow into the head-side oil chamber of the left leveling cylinder 23L and causes the hydraulic

oil flowing out from the rod-side oil chamber of the left leveling cylinder 23L to be discharged to the hydraulic oil tank T. In this case, the left leveling cylinder 23L expands, and the left leveling arm 3AL lowers. The same applies to the right leveling control valve 33R that expands the right leveling cylinder 23R.

[0079] The pilot check valve 33P is configured to prevent the leveling cylinder 23 from moving due to an external force. In the example shown in Fig. 3, the pilot check valve 33P includes pilot check valves 33PaL, 33PbL, 33PaR, and 33PbR. For example, only in a case where the left leveling control valve 33L operates in response to an operation by the operator and a hydraulic oil discharged by the cylinder pump 14M flows into the head-side oil chamber of the left leveling cylinder 23L, the pilot check valve 33PaL allows the hydraulic oil of the rod-side oil chamber of the left leveling cylinder 23L to flow toward the hydraulic oil tank T. In addition, in other cases, the pilot check valve 33PaL prohibits the hydraulic oil of the rod-side oil chamber of the left leveling cylinder 23L from flowing toward the hydraulic oil tank T. The same applies to the pilot check valves 33PbL, 33PaR, and 33PbR.

[0080] The hopper drive unit F6 is configured to be capable of opening and closing the hopper 2. In the present embodiment, the hopper drive unit F6 mainly includes the hopper cylinder 24, a hopper control valve 34, and a pilot check valve 34P.

[0081] The hopper cylinder 24 is a hydraulic actuator that opens and closes the hopper 2, contracts when opening the hopper 2, and expands when closing the hopper 2. In the example shown in Fig. 3, the hopper cylinder 24 includes a left hopper cylinder 24L and a right hopper cylinder 24R.

[0082] The hopper control valve 34 is configured to operate in accordance with a control signal from the controller 50. In the example shown in Fig. 3, the hopper control valve 34 includes a left hopper control valve 34L and a right hopper control valve 34R. In a case of opening the hopper 2, the left hopper control valve 34L causes a hydraulic oil discharged by the cylinder pump 14M to flow into a rod-side oil chamber of the left hopper cylinder 24L and causes a hydraulic oil flowing out from a head-side oil chamber of the left hopper cylinder 24L to be discharged to the hydraulic oil tank T. In this case, the left hopper cylinder 24L contracts. In addition, the right hopper control valve 34R causes a hydraulic oil discharged by the cylinder pump 14M to flow into a rod-side oil chamber of the right hopper cylinder 24R and causes a hydraulic oil flowing out from a head-side oil chamber of the right hopper cylinder 24R to be discharged to the hydraulic oil tank T. In this case, the right hopper cylinder 24R contracts. On the other hand, in a case of closing the hopper 2, the left hopper control valve 34L causes a hydraulic oil discharged by the cylinder pump 14M to flow into the head-side oil chamber of the left hopper cylinder 24L and causes a hydraulic oil flowing out from the rod-side oil chamber of the left hopper cylinder 24L to be

discharged to the hydraulic oil tank T. In this case, the left hopper cylinder 24L expands. In addition, the right hopper control valve 34R causes a hydraulic oil discharged by the cylinder pump 14M to flow into the head-side oil chamber of the right hopper cylinder 24R and causes a hydraulic oil flowing out from the rod-side oil chamber of the right hopper cylinder 24R to be discharged to the hydraulic oil tank T. In this case, the right hopper cylinder 24R expands.

[0083] The pilot check valve 34P is configured to prevent the hopper cylinder 24 from contracting and the hopper 2 from opening due to the weight of the hopper 2 or the weight of the hopper 2 and a paving material in the hopper 2. In the example shown in Fig. 3, the pilot check valve 34P includes the pilot check valve 34PL and the pilot check valve 34PR. For example, only in a case where the left hopper control valve 34L operates in response to an operation by the operator and a hydraulic oil discharged by the cylinder pump 14M flows into the rod-side oil chamber of the left hopper cylinder 24L, the pilot check valve 34PL allows the hydraulic oil of the head-side oil chamber of the left hopper cylinder 24L to flow toward the hydraulic oil tank T. In addition, in other cases, the pilot check valve 34PL prohibits the hydraulic oil of the head-side oil chamber of the left hopper cylinder 24L from flowing toward the hydraulic oil tank T. The same applies to the pilot check valve 34PR.

[0084] In the hopper drive unit F6, a pilot check valve is not provided between a rod-side oil chamber of the hopper cylinder 24 and the hopper control valve 34. This is because a probability in which the hopper cylinder 24 unintentionally expands due to an external force is low since the weight of the hopper 2 is great. However, the pilot check valve may be provided between the rod-side oil chamber of the hopper cylinder 24 and the hopper control valve 34.

[0085] The screed lift unit F7 is configured to be capable of lifting the screed 3. In the present embodiment, the screed lift unit F7 mainly includes the screed lift cylinder 25, a screed lift control valve 35, a switching valve 35a, a relief valve 35b, and a switching valve 35c.

[0086] The screed lift cylinder 25 is a hydraulic actuator that lifts the screed 3, contracts when lifting the screed 3, and expands when lowering the screed 3. In the example shown in Fig. 3, the screed lift cylinder 25 includes a left screed lift cylinder 25L and a right screed lift cylinder 25R.

[0087] The screed lift control valve 35 is configured to operate in accordance with a control signal from the controller 50. In a case of lifting the screed 3, the screed lift control valve 35 causes a hydraulic oil discharged by the cylinder pump 14M to flow into the rod-side oil chamber of the screed lift cylinder 25. In this case, the switching valve 35a switches to a first position including a check valve in accordance with a control signal from the controller 50. This is because a hydraulic oil is prevented from flowing backward from the rod-side oil chamber of the screed lift cylinder 25 toward the hydraulic oil tank T.

The hydraulic oil flowing out from a head-side oil chamber of the screed lift cylinder 25 is discharged to the hydraulic oil tank T without passing through the screed lift control valve 35. In this case, the screed lift cylinder 25 contracts. On the other hand, in a case of lowering the screed 3 to the ground, the screed lift control valve 35 is not used (maintained in the state shown in Fig. 3). In this case, the switching valve 35a switches to a second position where the check valve is not included in accordance with a control signal from the controller 50. This is because a hydraulic oil of the rod-side oil chamber of the screed lift cylinder 25 flows out toward the hydraulic oil tank T. For this reason, the screed lift cylinder 25 expands due to the weight of the screed 3, and the hydraulic oil of the rod-side oil chamber of the screed lift cylinder 25 is discharged to the hydraulic oil tank T through the switching valve 35a and the relief valve 35b.

[0088] The switching valve 35a and the relief valve 35b realize an up-and-down movement of the screed 3 accompanying a change of a lifting force (a force with which a paving material lifts the screed 3) generated when paving a road while moving the asphalt finisher 100. Specifically, when the screed 3 rises due to an increase in the lifting force, the screed lift cylinder 25 contracts. In this case, a hydraulic oil discharged by the cylinder pump 14M flows into the rod-side oil chamber of the screed lift cylinder 25 through a pipeline C3, the screed lift control valve 35, and the switching valve 35a. On the other hand, when the screed 3 is lowered due to a decrease in the lifting force, the screed lift cylinder 25 expands. In this case, a hydraulic oil flowing out from the rod-side oil chamber of the screed lift cylinder 25 is discharged to the hydraulic oil tank T through the switching valve 35a, the screed lift control valve 35, and the relief valve 35b. When paving a road while moving the asphalt finisher 100, that is, while the hydraulic device, such as the screed expansion and contraction unit F8 on a downstream side, is not used, the switching valve 35c switches to the first position including the check valve in accordance with a control signal from the controller 50. This is because the hydraulic device such as the screed expansion and contraction unit F8 on the downstream side is not to be adversely affected. Specifically, this is because the telescopic screed 31, a crown device, a step device, or the like is prevented from unintentionally moving.

[0089] The screed expansion and contraction unit F8 is configured to be capable of expanding and contracting the telescopic screed 31 in the vehicle width direction. In the present embodiment, the screed expansion and contraction unit F8 mainly includes the screed expanding and contracting cylinder 27, the screed expansion and contraction control valve 37, a pilot check valve 37P, and a relief valve 37V. In the example shown in Fig. 3, the screed expansion and contraction control valve 37 includes a left screed expansion and contraction control valve 37L and a right screed expansion and contraction control valve 37R. The pilot check valve 37P includes pilot check valves 37PaL, 37PaR, 37PbL, and 37PbR.

The relief valve 37V includes a left relief valve 37VL and a right relief valve 37VR.

[0090] The left screed expansion and contraction control valve 37L is configured to operate in accordance with a control signal from the controller 50. In a case of retracting the left telescopic screed 31L, the left screed expansion and contraction control valve 37L causes a hydraulic oil discharged by the cylinder pump 14M to flow into a rod-side oil chamber of the left screed expanding and contracting cylinder 27L and causes the hydraulic oil flowing out from a head-side oil chamber of the left screed expanding and contracting cylinder 27L to be discharged to the hydraulic oil tank T. In this case, the left screed expanding and contracting cylinder 27L contracts, and the left telescopic screed 31L is retracted. The same applies to a case where the right telescopic screed 31R is retracted. On the other hand, in a case of pushing out the left telescopic screed 31L, the left screed expansion and contraction control valve 37L causes a hydraulic oil discharged by the cylinder pump 14M to flow into the head-side oil chamber of the left screed expanding and contracting cylinder 27L and causes the hydraulic oil flowing out from the rod-side oil chamber of the left screed expanding and contracting cylinder 27L to be discharged to the hydraulic oil tank T. In this case, the left screed expanding and contracting cylinder 27L expands, and the left telescopic screed 31L is pushed out.

[0091] The pilot check valve 37P is configured to prevent the screed expanding and contracting cylinder 27 from unintentionally moving due to an external force. For example, only in a case where the left screed expansion and contraction control valve 37L operates in response to an operation by the operator and a hydraulic oil discharged by the cylinder pump 14M flows into the head-side oil chamber of the left screed expanding and contracting cylinder 27L, the pilot check valve 37PaL allows the hydraulic oil of the rod-side oil chamber of the left screed expanding and contracting cylinder 27L to flow toward the hydraulic oil tank T. In addition, in other cases, the pilot check valve 37PaL prohibits the hydraulic oil of the rod-side oil chamber of the left screed expanding and contracting cylinder 27L from flowing toward the hydraulic oil tank T. The same applies to the pilot check valves 37PbL, 37PaR, and 37PbR.

[0092] The relief valve 37V is configured to prevent a member related to the telescopic screed 31 from being destroyed by an excessive external force acting on a direction in which the telescopic screed 31 is retracted. For example, in a case where the pressure of a hydraulic oil in the head-side oil chamber of the left screed expanding and contracting cylinder 27L has been excessively risen by receiving an excessive external force acting on a direction in which the left screed expanding and contracting cylinder 27L is contracted, the left relief valve 37VL allows the hydraulic oil in the head-side oil chamber to flow out to the hydraulic oil tank T. As a result, as the left screed expanding and contracting cylinder 27L contracts and some of the external force is absorbed, the left telescopic

screed 31L is prevented from being damaged. The same applies to the right relief valve 37VR.

<Functional Block of Controller>

[0093] Each functional block in the controller 50 of the asphalt finisher 100 will be described. Each functional block in the controller 50 is conceptual and does not necessarily have to be physically configured as shown. All or some of the respective functional blocks can be configured by being functionally or physically distributed and integrated in any unit. All or any part of the respective processing functions performed in the respective functional blocks are realized by a program executed by the CPU. Alternatively, each functional block may be realized as hardware by wired logic. A program executed by such a controller 50 according to the present embodiment is not limited to a method of storing in a non-volatile auxiliary storage device, may be stored in a distributable storage unit medium, and may be transmitted and received via a communication line NW.

[0094] In accordance with detection results from the GPS module 54, the front monitoring device 51F, the rear monitoring device 51B, and the traveling speed sensor 47, the controller 50 according to the present embodiment performs self-localization and performs automatic movement control in order to pave, with asphalt, a road surface indicated by schedule information stored in the auxiliary storage device 48.

[0095] In that case, the controller 50 transmits, to the screed control device 55, a control command for extending or shrinking the telescopic screed 31 based on measurement information from the screed length detection device 57 such that a paving material does not project from the road surface, which is a pavement target.

[0096] The side plate 40 is attached to the distal end of the telescopic screed 31. For this reason, in a case where the telescopic screed 31 shrinks in the vehicle width direction, there is a possibility in which the side plate 40 comes into contact with the screw.

[0097] Thus, the controller 50 according to the present embodiment controls expansion and contraction of the telescopic screed 31 such that the length of the telescopic screed 31 (an example of a screed device) in the vehicle width direction does not fall below a predetermined length based on the screw SC.

[0098] The predetermined length based on the screw SC is a length determined such that the side plate 40 does not come into contact with the screw SC and is, for example, a length obtained by adding a predetermined margin to the length of the screw SC in the vehicle width direction, that is, a length that is equal to or larger than the length of the screw SC in the vehicle width direction. Accordingly, the telescopic screed 31 can suppress contact with the screw SC.

[0099] More specifically, the controller 50 has a communication control unit 50a, a setting unit 50b, an acquisition unit 50c, a moving route calculation unit 50d, a

movement control unit 50e, and a screed control unit 50f as functional blocks configured by software, hardware, or a combination thereof.

[0100] The communication control unit 50a transmits and receives information to and from an external device.

[0101] For example, the communication control unit 50a may receive information related to the extended screw connected to the asphalt finisher 100 from a radio frequency identification (RFID) reader or a two-dimensional bar code reader.

[0102] The setting unit 50b registers the length of the screw SC of the asphalt finisher 100 in the screw length storage unit 48b based on information related to the extended screw, which is received by the communication control unit 50a. Next, the extended screw connected to the asphalt finisher 100 will be described.

[0103] In the asphalt finisher 100 according to the present embodiment, an extended screw to be connected is different depending on the width of a road, which is a pavement target.

[0104] Fig. 4 is an explanatory view of the screw SC included in the asphalt finisher 100 according to the present embodiment. As shown in Fig. 4, in the asphalt finisher 100, there are a plurality of types of extended screws connectable to the left main screw SCLM. The example shown in Fig. 4 is an example in which there are the first left extension screw SCLE1 and a second left extension screw SCLE2. Each of the first left extension screw SCLE1 and the second left extension screw SCLE2 is connectable to the left main screw SCLM. The length of the first left extension screw SCLE1 is, for example, 1 m, and the length of the second left extension screw SCLE2 is, for example, 50 cm. As described above, the length of the extended screw is different depending on the type.

[0105] In addition, all of the first left extension screw SCLE1, the second left extension screw SCLE2, and the left main screw SCLM may be connected to each other. As a connection method, any method may be used, and for example, a bolt fastening may be used.

[0106] The worker fastens the extended screw to the main screw depending on the width of a road to be paved by the asphalt finisher 100. In the present embodiment, as described above, it is necessary for the controller 50 to recognize the length of the screw SC in order to perform control such that the length of the telescopic screed 31 in the vehicle width direction does not fall below the predetermined length based on the screw SC.

[0107] Thus, the worker performs work of setting the length of the extended screw connected to the asphalt finisher 100.

[0108] For example, in a case where RFID44L1 is embedded in the first left extension screw SCLE1 and RFID44L2 is embedded in the second left extension screw SCLE2, the worker reads RFID (for example, RFID44L1) of the extended screw connected to the asphalt finisher 100 (for example, the first left extension screw SCLE1) with the RFID reader (not shown). The

information read with the RFID reader includes information for identifying a connected extended screw (for example, the first left extension screw SCLE1) and information indicating the length of the extended screw.

[0109] In addition, the RFID reader transmits the read information to the communication device 53 of the asphalt finisher 100.

[0110] In addition, the communication control unit 50a receives information for identifying a connected extended screw (for example, the first left extension screw SCLE1) or information indicating the length of the extended screw from the RFID reader via the communication device 53.

[0111] The setting unit 50b registers, in the screw length storage unit 48b, the length of the screw SC after the extended screw is connected to the asphalt finisher 100 based on the received information. For example, in a case where information for identifying an extended screw is received, the setting unit 50b identifies the length of the connected extended screw from an association relationship between the information for identifying an extended screw (for example, a model number and RFID) and the length of the extended screw, which is stored in the screw length storage unit 48b. In addition, the setting unit 50b registers the identified length in the screw length storage unit 48b.

[0112] Further, the setting unit 50b registers the length of the screw SC, which is a total of the length of the extended screw and the length of the main screw, in the screw length storage unit 48b.

[0113] Further, the setting unit 50b sets a predetermined length, which is reference when performing screw expansion and contraction control, based on the length of the screw SC. Control using the predetermined length will be described later.

[0114] A case where a transmission source of information related to a connected extended screw is a RFID reader has been described in the present embodiment. However, the present embodiment does not limit the transmission source to the RFID reader, and for example, a mobile communication device of the worker may be used. For example, in a case where a two-dimensional bar code is bonded to the extended screw, an imaging device included in the mobile communication device images the two-dimensional bar code, and the mobile communication device may transmit information extracted from the two-dimensional bar code to the communication device 53. Further, an input device provided in the asphalt finisher 100 may receive an input of information related to an extended screw (for example, a model number) or the length of the extended screw. In these cases, the setting unit 50b registers, in the screw length storage unit 48b, the length of the extended screw and the length of the screw SC based on the information.

[0115] In addition, in a case where the length of the extended screw registered by the setting unit 50b does not correspond to the width of a road of schedule information stored in the schedule information storage unit

48a, the controller 50 may output an alarm before starting construction. Further, the controller 50 may suppress start of automatic control until information of the extended screw corresponding to the width of the road of the schedule information is registered.

[0116] Referring back to Fig. 2, the acquisition unit 50c acquires various types of information. For example, the acquisition unit 50c acquires measurement information from various types of sensors. For example, the acquisition unit 50c acquires measurement information from the front monitoring device 51F, the rear monitoring device 51B, the traveling speed sensor 47, and the screed length detection device 57. As another example, the acquisition unit 50c acquires position information from the GPS module 54. Further, the acquisition unit 50c acquires information from the auxiliary storage device 48 as necessary.

[0117] The moving route calculation unit 50d calculates a moving route of the asphalt finisher 100 based on schedule information read from the schedule information storage unit 48a.

[0118] The movement control unit 50e outputs a control command based on measurement information and position information acquired by the acquisition unit 50c to the drive system controller 52 to move along the calculated moving route. Accordingly, automatic movement control of the asphalt finisher 100 is performed.

[0119] The screed control unit 50f outputs a control command for expanding and contracting the telescopic screed 31 to the screed control device 55 based on measurement information of the screed length detection device 57 (an example of a detection result) to correspond to the width of a road surface on which a paving material is sprinkled. Accordingly, since the length of the screed 3 in the vehicle width direction can be made to match the width of a road, which is a construction target, the paving material can be appropriately leveled on the road surface, which is a pavement target.

[0120] However, when performing control of shrinking the telescopic screed 31 to correspond to the width of the road surface on which the paving material is sprinkled, the screed control unit 50f suppresses control of shrinking the telescopic screed 31 in a case where the length of the telescopic screed 31 in the vehicle width direction is a predetermined length.

[0121] Specifically, when performing control of shrinking the telescopic screed 31, the screed control unit 50f suppresses control of shrinking the telescopic screed 31 even when the side plate 40 has projected to an outside (road shoulder side) of the road surface in a case where it is detected that the length of the telescopic screed 31 in the vehicle width direction is a predetermined length based on measurement information of the screed length detection device 57. Next, suppression of control of shrinking the telescopic screed 31 performed by the screed control unit 50f will be described later.

<Description of Moving Route of Asphalt Finisher>

[0122] Fig. 5 is a view showing a moving route of the asphalt finisher 100 based on schedule information according to the present embodiment. In the example shown in Fig. 5, a case where the asphalt finisher 100 moves in a traveling direction 5001 will be described.

[0123] In order to move in accordance with a road, which is a pavement target, the movement control unit 50e of the asphalt finisher 100 controls the tractor 1 such that the center of the asphalt finisher 100 matches a center line CL1 of the road, which is the pavement target.

[0124] Further, the screed control unit 50f outputs, to the screed control device 55, a control command for expanding and contracting the left telescopic screed 31L such that the left side plate 40L matches a target line OLL on the left side. Similarly, the screed control unit 50f outputs, to the screed control device 55, a control command for expanding and contracting the right telescopic screed 31R such that the right side plate 40R matches a target line OLR on the right side. Accordingly, in a case where the center of the asphalt finisher 100 is slightly shifted from the center line CL1 of the road, which is a pavement target, a paving material can be appropriately leveled on the road surface, which is a pavement target.

[0125] However, in a case where the center of the asphalt finisher 100 matches the center line CL1, a length from the center line CL1 to an end portion of the road on the left is L1, and a length from the center line CL1 to an end portion of the road on the right is the length L1. For this reason, the screed control unit 50f may perform expansion and contraction control such that lengths from the center of the asphalt finisher 100 to the right side plate 40R and the left side plate 40L become the length L1.

[0126] However, in the asphalt finisher 100, in a case where the movement control unit 50e performs automatic control, the center of the asphalt finisher 100 is shifted from the center line CL1 in some cases. For example, in a case where the road is curved, the center of the asphalt finisher 100 is shifted from the center line CL1 when a delay occurs at a timing when the movement control unit 50e changes a steering angle through the automatic control of the tractor 1. In this case, for example, it is conceivable that the center of the asphalt finisher 100 moves along a route CL2.

[0127] In this case, the screed control unit 50f performs expansion and contraction control of the left telescopic screed 31L such that a length from the center of the asphalt finisher 100 to the left side plate 40L becomes a length L3.

[0128] It is necessary for the screed control unit 50f to perform expansion and contraction control of the right telescopic screed 31R such that a length from the center of the asphalt finisher 100 to the right side plate 40R becomes a length L2. However, in a case of shrinking the right telescopic screed 31R such that the length from the center of the asphalt finisher 100 to the right side

plate 40R becomes the length L2, there is a possibility in which the right side plate 40R comes into contact with the screw SC.

[0129] Fig. 6 is a view showing a positional relationship between the left side plate 40L and the screw SC according to the present embodiment. Although Fig. 6 shows the positional relationship between the screw SC, in which the first left extension screw SCLE1 is connected to the left main screw SCLM, and the left side plate 40L, the same applies to a positional relationship between the screw SC and the right side plate 40R.

[0130] In the example shown in Fig. 6, the traveling direction 5001 is adopted. Thus, as the left main screw SCLM and the first left extension screw SCLE1 rotate in an arrow 6001 direction through control by the screw control device 56, a paving material is pushed out in a road shoulder direction (a direction in which there is the target line OLL).

[0131] In addition, the screed control unit 50f performs expansion and contraction control for the left screed expanding and contracting cylinder 27L such that the left side plate 40L matches the target line OLL on the left side. Description of the telescopic mold board 41 will be omitted assuming that the telescopic mold board 41 expands and contracts in accordance with the expansion and contraction control for the left screed expanding and contracting cylinder 27L.

[0132] In a case where it is detected that the left side plate 40L is shifted to the right side of the target line OLL on the left side, the screed control unit 50f performs control of extending the left screed expanding and contracting cylinder 27L and moves the left side plate 40L in a left arrow direction 6002.

[0133] Similarly, in a case where it is detected that the left side plate 40L is shifted to the left side of the target line OLL on the left side, the screed control unit 50f performs control of shrinking the left screed expanding and contracting cylinder 27L and moves the left side plate 40L in a right arrow direction 6003. However, in a case where the left side plate 40L moves excessively in the right arrow direction 6003, the left side plate 40L comes into contact with an end portion of the first left extension screw SCLE1.

[0134] Thus, the screed control unit 50f according to the present embodiment performs control such that the length of the telescopic screed 31 (an example of the screed device) in the vehicle width direction does not fall below the predetermined length in order to make sure that the left side plate 40L does not come into contact with the first left extension screw SCLE1.

[0135] Referring back to Fig. 5, when performing control of shrinking the telescopic screed 31, the screed control unit 50f suppresses control of shrinking the telescopic screed 31 in a case where the length of the telescopic screed 31 in the vehicle width direction is the predetermined length. Accordingly, the right side plate 40R moves along a movement line 5011 projecting to the road shoulder side of the target line OLR on the right side. Accord-

ingly, a paving material projects to the road shoulder, but it can be suppressed that the right side plate 40R comes into contact with the screw SC. Therefore, as the controller 50 performs the control described above, it can be suppressed that the right side plate 40R comes into contact with the screw SC, and improvement of safety can be realized.

[0136] In a case of suppressing control of shrinking the telescopic screed 31, the controller 50 according to the present embodiment can perform various types of control.

[0137] For example, in a case where the screed control unit 50f suppresses control of shrinking the telescopic screed, the movement control unit 50e may perform control of decreasing the speed of the tractor 1 of the asphalt finisher 100.

[0138] That is, in a case where the screed control unit 50f suppresses control of shrinking the telescopic screed 31, the movement control unit 50e estimates that the center of the asphalt finisher 100 is shifted from the center line of the road. Then, in order to correct the shift, the movement control unit 50e performs control of decreasing the speed of the tractor 1. By correcting a moving direction of the asphalt finisher 100 after decreasing the speed, the movement control unit 50e can again start control of expanding and contracting the telescopic screed 31 such that the side plate 40 matches the target line. Therefore, since the moving direction can be corrected twice as much as the speed is decreased, the paving accuracy of the road surface can be improved. In addition, the movement control unit 50e may stop the tractor 1 in a case where correcting the moving direction is difficult or a case where it is recognized that an abnormality has occurred after decreasing the speed of the tractor 1.

[0139] As another example, the communication control unit 50a may transmit information indicating that the screed control unit 50f has suppressed control of shrinking the telescopic screed 31 to an external device. For example, the communication control unit 50a transmits the information indicating that control of shrinking the telescopic screed 31 is suppressed to a load roller behind the asphalt finisher 100 in the traveling direction. Accordingly, the load roller can perform control based on the information. In addition, the communication control unit 50a may transmit the information indicating that control of shrinking the telescopic screed 31 is suppressed to a mobile communication device of the worker existing in the surroundings. By transmitting the information, a subsequent load roller or a worker can take follow-up measures. For example, the worker can perform work of returning a paving material projecting to the road shoulder to the road surface. Therefore, the communication control unit 50a can improve the paving accuracy of the road surface by transmitting the information described above. Further, the communication control unit 50a may transmit the information indicating that control of shrinking the telescopic screed 31 is suppressed to a management serv-

er that manages work history. Accordingly, in the present embodiment, work history of the asphalt finisher 100 can be managed.

5 <Description of Control Procedures in Automatic Movement Control by Asphalt Finisher>

[0140] Fig. 7 is a flowchart showing control of the asphalt finisher 100 by the controller 50 according to the present embodiment. In the example shown in Fig. 7, the length of the screw SC is already registered in the screw length storage unit 48b.

[0141] First, before performing automatic control, the acquisition unit 50c of the controller 50 acquires a predetermined length based on the length of the screw SC from the screw length storage unit 48b of the auxiliary storage device 48 (S7001).

[0142] Next, before performing the automatic control, the acquisition unit 50c acquires schedule information from the schedule information storage unit 48a of the auxiliary storage device 48 (S7002).

[0143] The moving route calculation unit 50d calculates the moving route of the asphalt finisher 100 in accordance with the schedule information (S7003).

[0144] Then, the movement control unit 50e starts movement control to move along the calculated moving route (S7004).

[0145] The acquisition unit 50c acquires measurement information from each of the front monitoring device 51F, the rear monitoring device 51B, the traveling speed sensor 47, and the screed length detection device 57, together with acquiring position information from the GPS module 54 (S7005).

[0146] Based on the position information and the measurement information of each of the front monitoring device 51F, the rear monitoring device 51B, and the traveling speed sensor 47, the movement control unit 50e performs movement control to move along the moving route (S7006).

[0147] The screed control unit 50f determines, based on the measurement information of the screed length detection device 57 and the position of the target line indicated by the schedule information, whether or not the side plate 40 is shifted from the target line (S7007). In a case where it is determined that the side plate 40 is not shifted from the target line (S7007: No), expansion and contraction control is not performed, and processing proceeds to S7011.

[0148] In a case where it is determined that the side plate 40 is shifted from the target line (S7007: Yes), the screed control unit 50f determines whether or not expansion and contraction control for correcting the shift is control of shrinking the length of the telescopic screed 31 in the vehicle width direction to fall below the predetermined length (S7008).

[0149] In a case where it is determined not to be the control of shrinking the length of the telescopic screed 31 in the vehicle width direction to fall below the prede-

terminated length (S7008: No), the screed control unit 50f performs the expansion and contraction control for correcting the shift (S7009).

[0150] On the other hand, in a case where it is determined to be the control of shrinking the length of the telescopic screed 31 in the vehicle width direction to fall below the predetermined length (S7008: Yes), the control of shrinking is stopped (S7010).

[0151] After then, the movement control unit 50e determines whether or not movement along the moving route is completed (S7011). In a case where it is determined to be not completed (S7011: No), processing is again performed from S7005.

[0152] On the other hand, in a case where the movement control unit 50e determines that movement along the moving route is completed (S7011: Yes), processing is completed.

[0153] In a case of performing movement control, the controller 50 according to the present embodiment can perform expansion and contraction control of the telescopic screed 31 in accordance with the width of the road. In that case, in a case where the control of shrinking the length of the telescopic screed 31 in the vehicle width direction to fall below the predetermined length is necessary, it can be suppressed that the side plate 40 comes into contact with the screw SC by stopping the control of shrinking.

(Modification Example)

[0154] A case where the controller 50 performs expansion and contraction control of the telescopic screed 31 in a case of performing automatic movement control of the asphalt finisher 100 has been described in the embodiment described above. However, suppression of the control of shrinking the telescopic screed 31 is not limited to a case of performing automatic movement control as in the embodiment described above and may be performed in a case where an operation of shrinking the telescopic screed 31 is received from the worker. Thus, a case where the operation of shrinking the telescopic screed 31 is received from the worker will be described in a modification example.

[0155] The asphalt finisher 100 according to the present modification example moves in accordance with steering by the operator seated in the driver's seat 1S. Further, the asphalt finisher 100 according to the present modification example performs expansion and contraction control of the telescopic screed 31 in accordance with an operation from the worker.

[0156] Fig. 8 is a rear view of the asphalt finisher 100. In the example shown in Fig. 8, an input unit 55L receives, from the worker, an operation for expanding and contracting the left telescopic screed 31L to the left side in the vehicle width direction with respect to the main screed 30. An input unit 55R receives, from the worker, an operation for expanding and contracting the right telescopic screed 31R to the right side in the vehicle width direction

with respect to the main screed 30. The input unit 55L and the input unit 55R output information of the received operations to the controller 50.

[0157] Accordingly, the screed control unit 50f of the controller 50 performs expansion and contraction control of the telescopic screed 31 in accordance with the information of the received operations.

[0158] In addition, when performing control of shrinking the telescopic screed 31 based on an operation input from the input unit 55L or the input unit 55R, the screed control unit 50f suppresses control of shrinking the telescopic screed 31 in a case where the length of the telescopic screed 31 in the vehicle width direction is the predetermined length.

[0159] As the screed control unit 50f performs the control described above in the present modification example, it can be suppressed that the screw SC comes into contact with the side plate 40 even in a case where the worker performs expansion and contraction control of the telescopic screed 31. For this reason, the asphalt finisher 100 according to the present modification example can realize improvement of safety.

[0160] A case where the input device that receives an operation from the worker is the input unit 55L and the input unit 55R has been described in the present modification example. However, the present modification example is not limited to an example including the input unit 55L and the input unit 55R. For example, expansion and contraction control of the left telescopic screed 31L and the right telescopic screed 31R may be performed with one input device. The input device is not limited to an example of being provided close to the rear surface of the asphalt finisher 100, maybe provided at the driver's seat 1S, or maybe an attachable and detachable device that performs wireless communication.

<Action>

[0161] By including the configuration described above, the controller 50 of the asphalt finisher 100 according to the embodiment and the modification example described above performs expansion and contraction control of the telescopic screed 31 such that the length of the telescopic screed 31 in the vehicle width direction does not fall below the predetermined length based on the screw SC when performing the expansion and contraction control of the telescopic screed 31 in accordance with the width of the road surface. Accordingly, since it can be suppressed that the side plate 40 provided at a far end portion of the telescopic screed 31 comes into contact with the screw SC, improvement of safety can be realized.

[0162] In addition, in a case of connecting the extended screw, the predetermined length is set based on a total length obtained by adding the length of the extended screw to the length of the main screw. For example, in a case where the length of the screw SC is changed according to the width of the road when constructing the asphalt finisher 100, control is performed such that the

side plate 40 does not come into contact with the screw SC after the length is changed. Therefore, since contact with the side plate 40 is suppressed even when the length of the screw SC is changed, improvement of safety can be realized.

[0163] Although the embodiment has been described in detail hereinbefore, the present disclosure is not limited to such a specific embodiment, various modifications and changes are possible within the scope of the concept described in the scope of claims.

[0164] Although the embodiment of the asphalt finisher has been described hereinbefore, the present invention is not limited to the embodiment or the like. Various types of changes, modifications, substitutions, additions, deletions, and combinations thereof are possible within the scope of the claims. It is evident that these belong to the technical scope of the present invention.

Brief Description of the Reference Symbols

[0165]

100 asphalt finisher	
SCLM left main screw	
SCRM right main screw	
SCLE1 first left extension screw	
SCRE1 first right extension screw	
27L left screed expanding and contracting cylinder	
27R right screed expanding and contracting cylinder	
30 main screed	30
31L left telescopic screed	
31R right telescopic screed	
47 traveling speed sensor	
48 auxiliary storage device	
48a schedule information storage unit	35
48b screw length storage unit	
50 controller	
50a communication control unit	
50b setting unit	
50c acquisition unit	40
50d moving route calculation unit	
50e movement control unit	
50f screed control unit	
51F front monitoring device	
51B rear monitoring device	45
52 drive system controller	
53 communication device	
54 GPS module	
55 screed control device	50
56 screw control device	

Claims

1. An asphalt finisher (100) comprising:
 - a tractor (1);
 - a hopper (2) that is provided on a front side of

the tractor (1) ;
a conveyor (CV) that transports a paving material in the hopper (2) to a rear side of the tractor (1);

a screw (3) that spreads the paving material, which is transported by the conveyor (CV) and which is sprinkled to a road surface, in a vehicle width direction; and

a screed device (31) that levels the paving material spread by the screw (3) on a rear side of the screw (3) and that is capable of expanding and contracting in the vehicle width direction, wherein expansion and contraction of the screed device (31) is configured to be controlled such that a length of the screed device (31) in the vehicle width direction does not fall below a predetermined length based on the screw (3).

2. The asphalt finisher (100) according to claim 1, wherein when performing control of shrinking the screed device (31) to correspond to a width of the road surface to which the paving material is sprinkled, the control of shrinking the screed device (31) is configured to be suppressed in a case where the length of the screed device (31) in the vehicle width direction is the predetermined length.

3. The asphalt finisher (100) according to claim 2, wherein when performing the control of shrinking the screed device (31) based on a detection result of the length of the screed device (31) in the vehicle width direction to correspond to the width of the road surface to which the paving material is sprinkled, the control of shrinking the screed device (31) is configured to be suppressed in a case where the length of the screed device (31) in the vehicle width direction is the predetermined length.

4. The asphalt finisher (100) according to claim 2, further comprising:

an input device (55L, 55R) that inputs an operation of expansion and contraction of the screed device (31),

wherein when performing the control of shrinking the screed device (31) based on the operation input from the input device (55L, 55R), the control of shrinking the screed device (31) is configured to be suppressed in a case where the length of the screed device (31) in the vehicle width direction is the predetermined length.

5. The asphalt finisher (100) according to any one of claims 2 to 4, wherein in a case where the control of shrinking the screed device (31) is suppressed, control of decreasing a speed of the asphalt finisher (100) is configured to be performed.

6. The asphalt finisher (100) according to any one of claims 2 to 5, wherein information indicating that the control of shrinking the screed device (31) is suppressed is configured to be transmitted to an external device. 5
7. The asphalt finisher (100) according to any one of claims 1 to 6, wherein the predetermined length is configured to be set based on the length of the screw (3) in the vehicle width direction. 10

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FIG. 1A

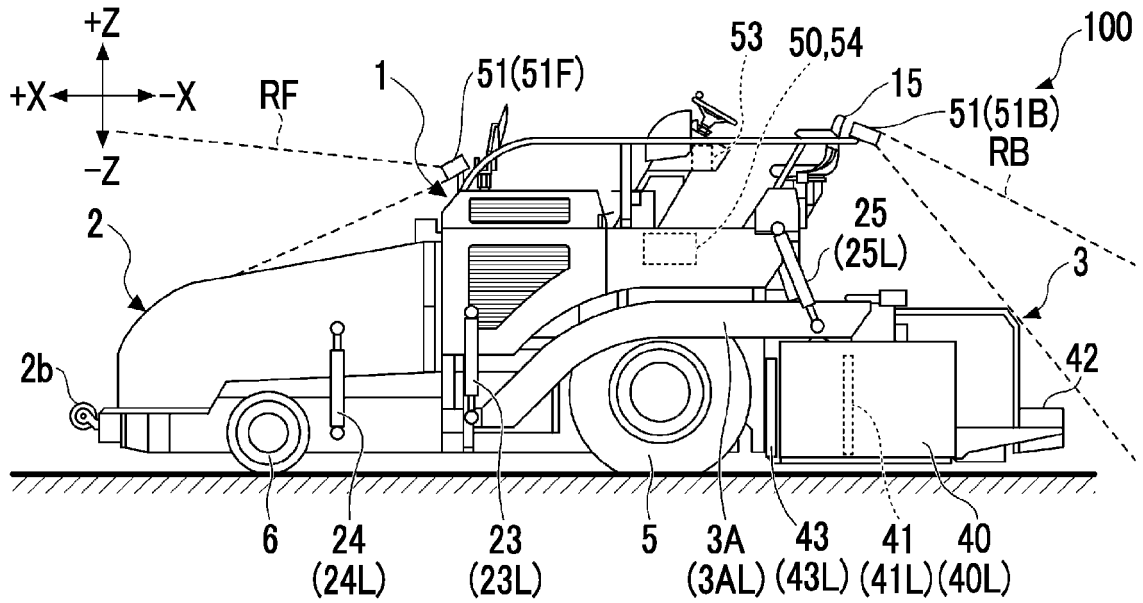


FIG. 1B

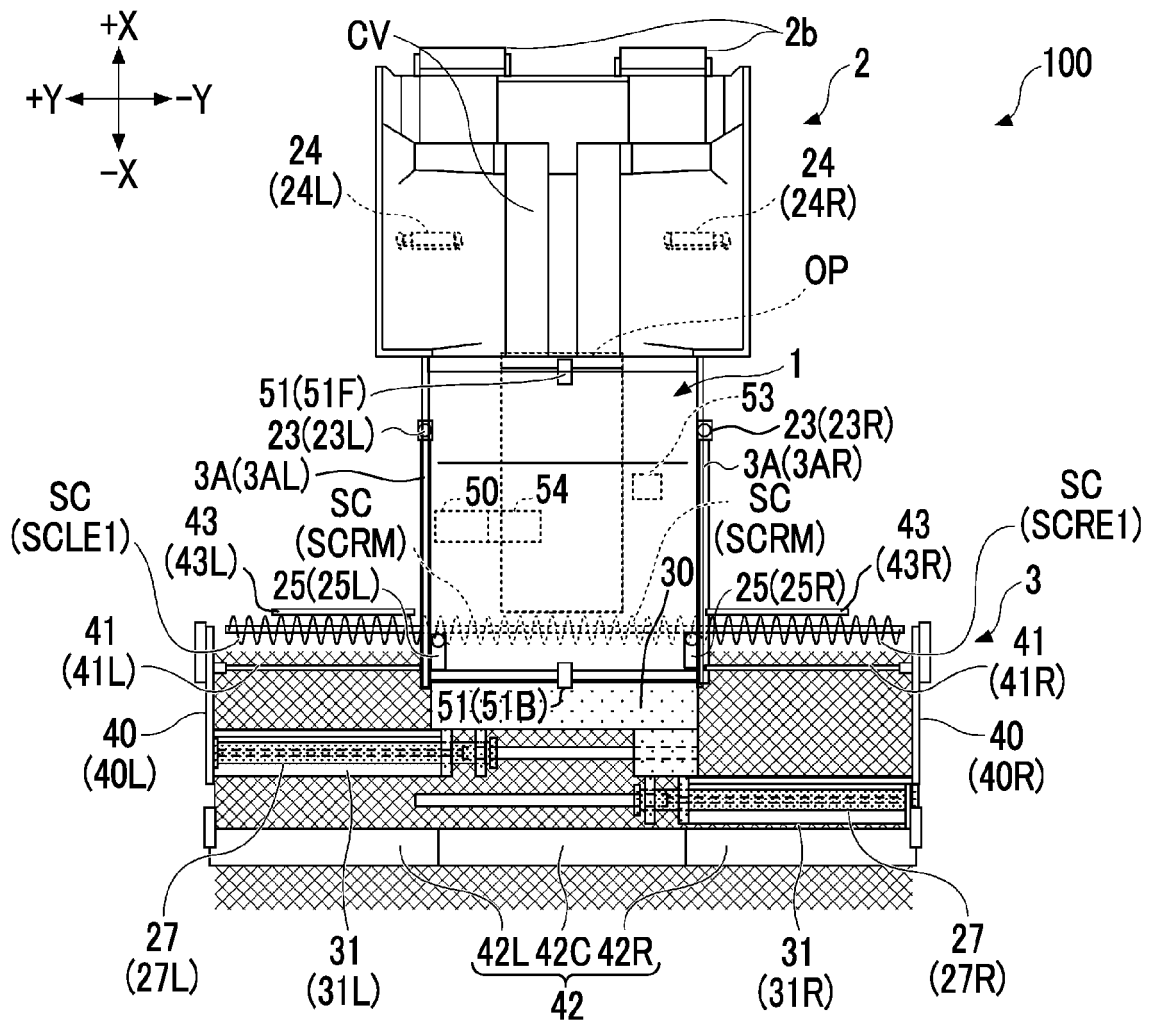


FIG. 2

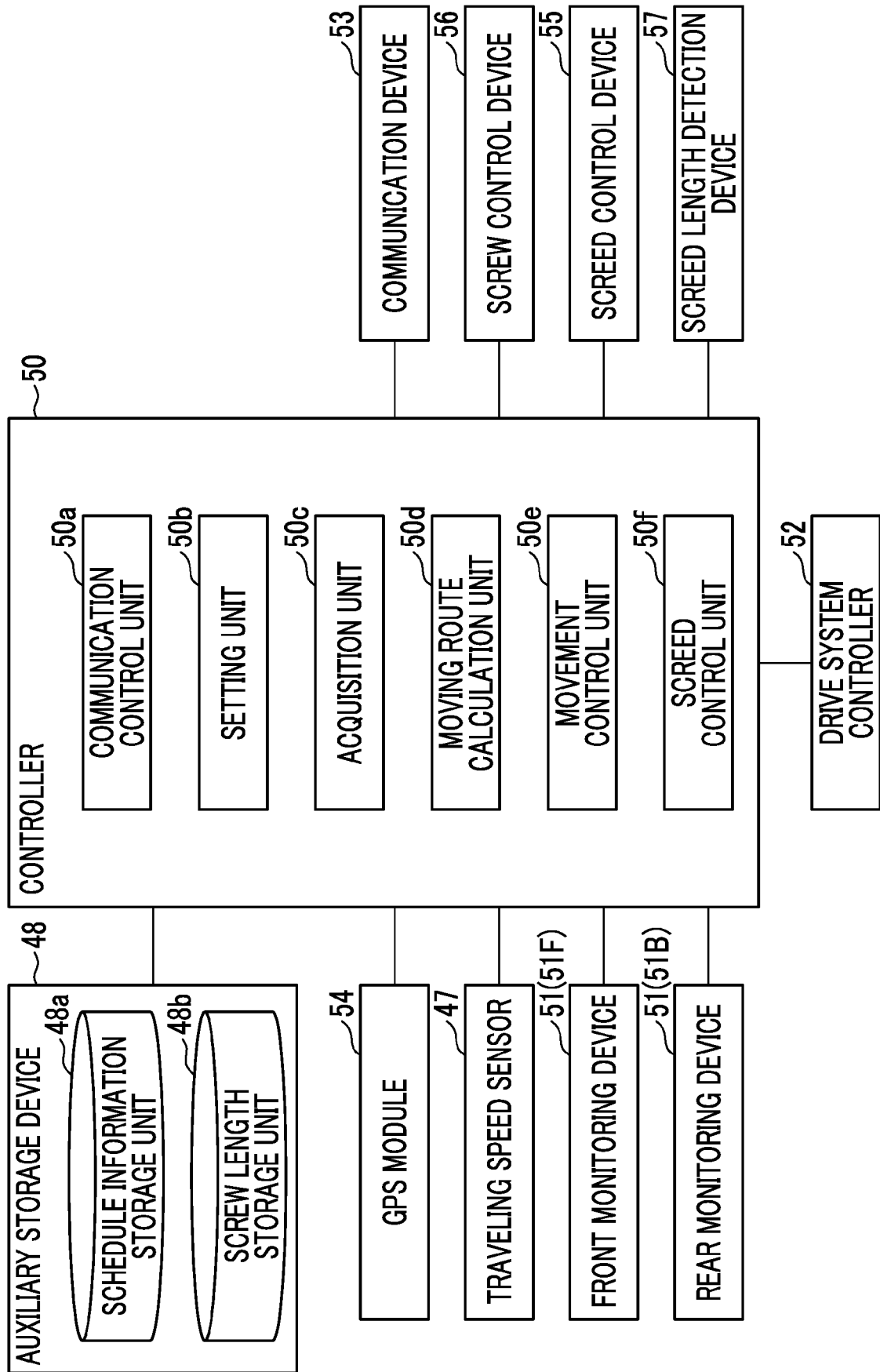


FIG. 3

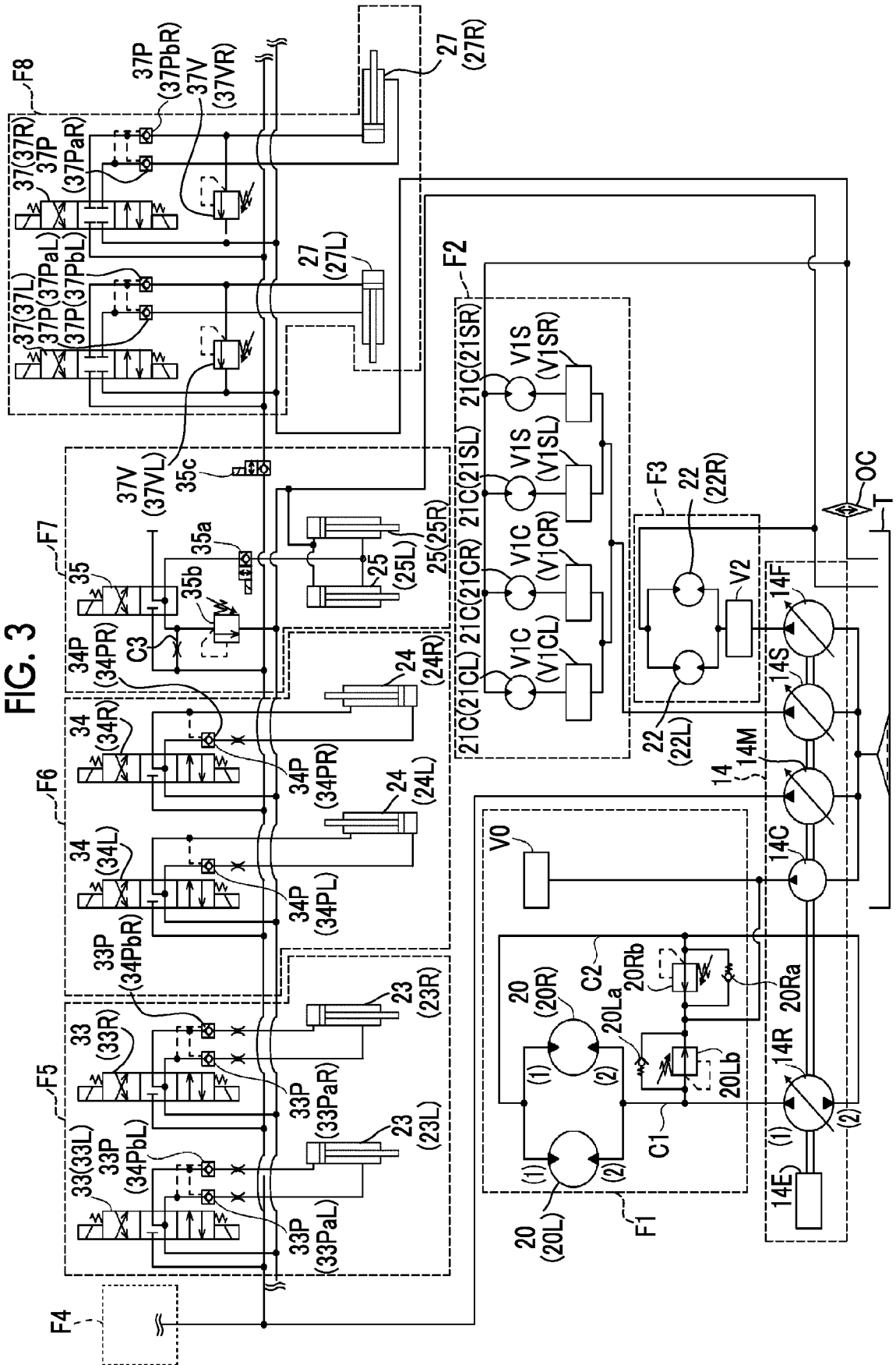


FIG. 4

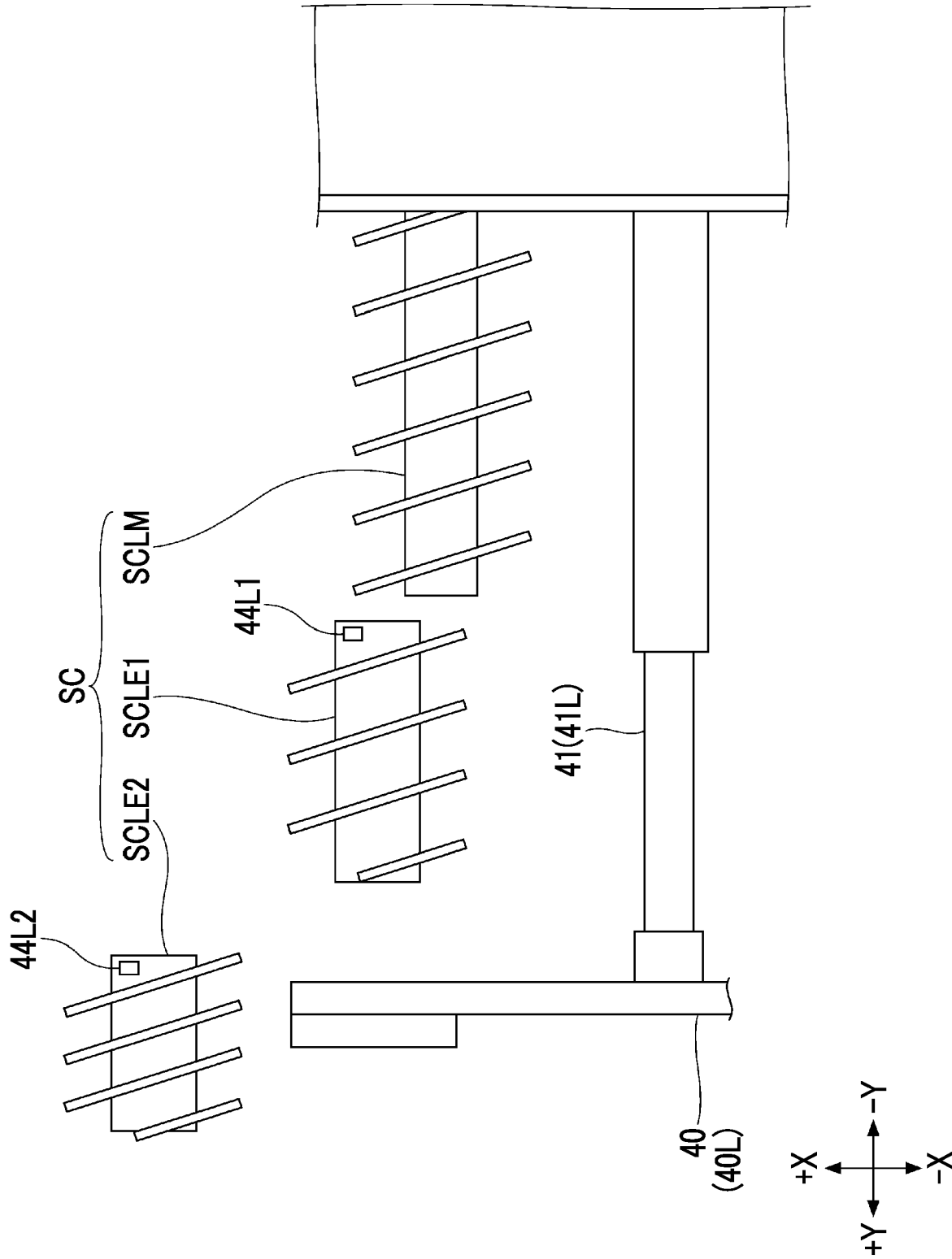


FIG. 5

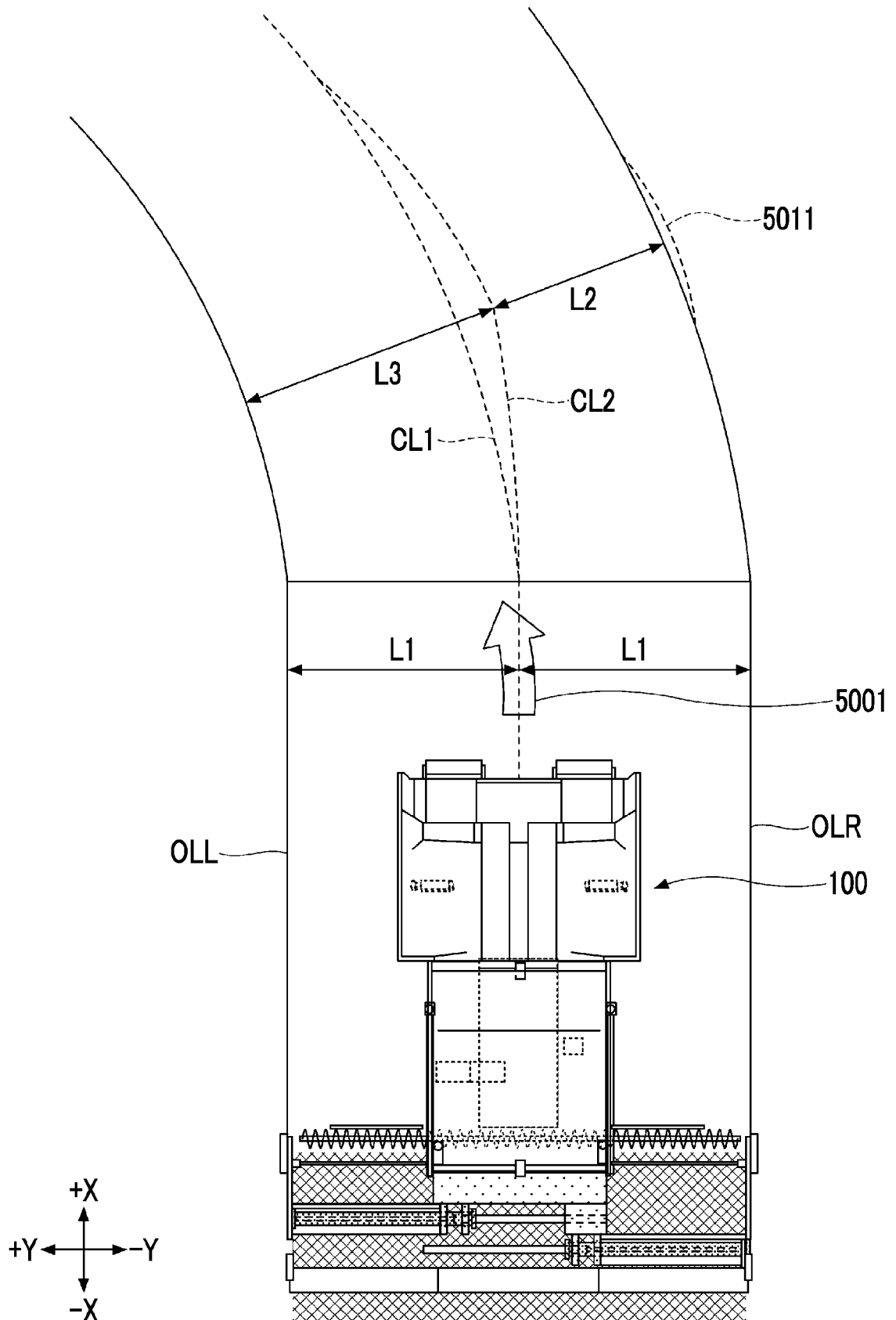


FIG. 6

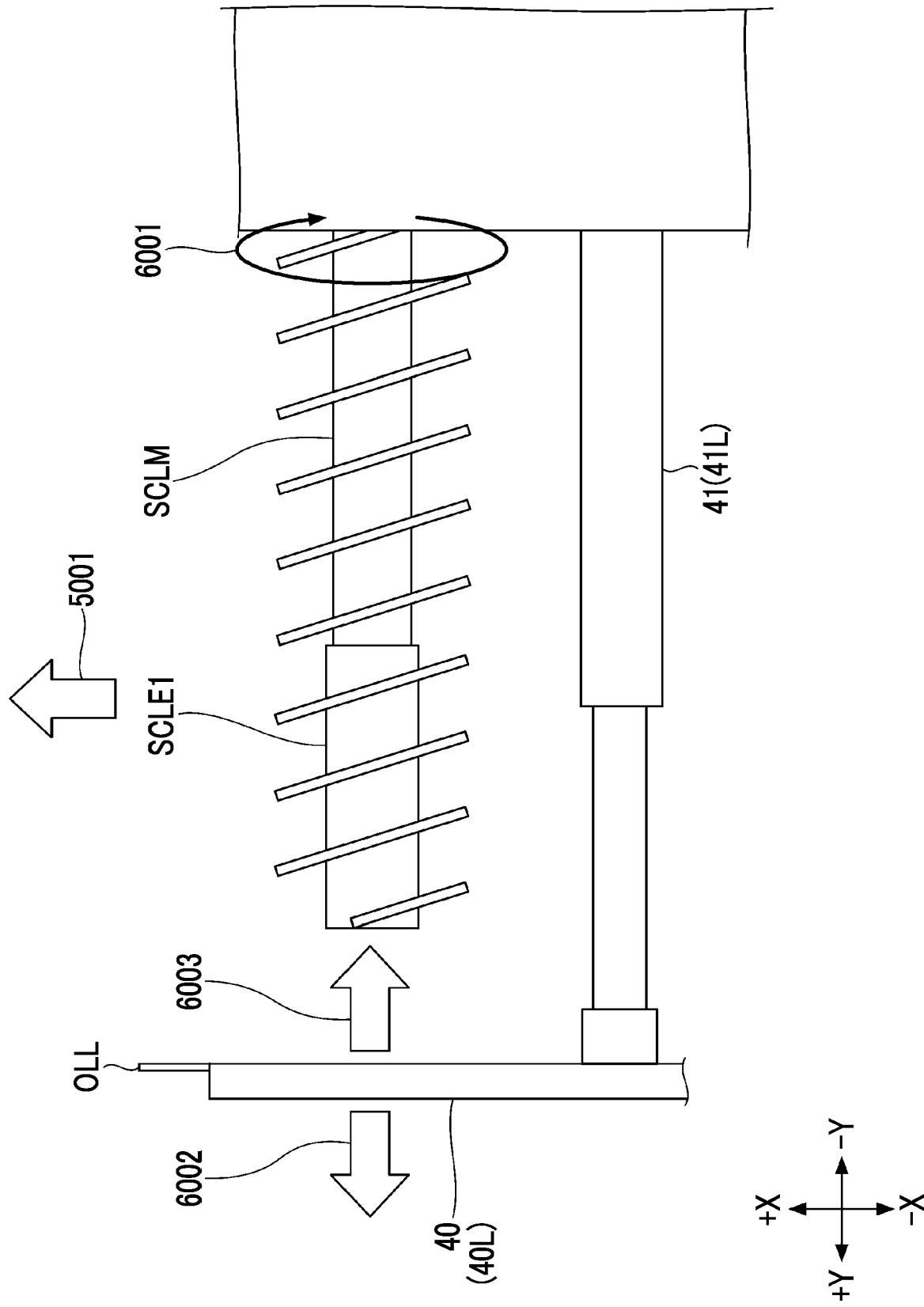


FIG. 7

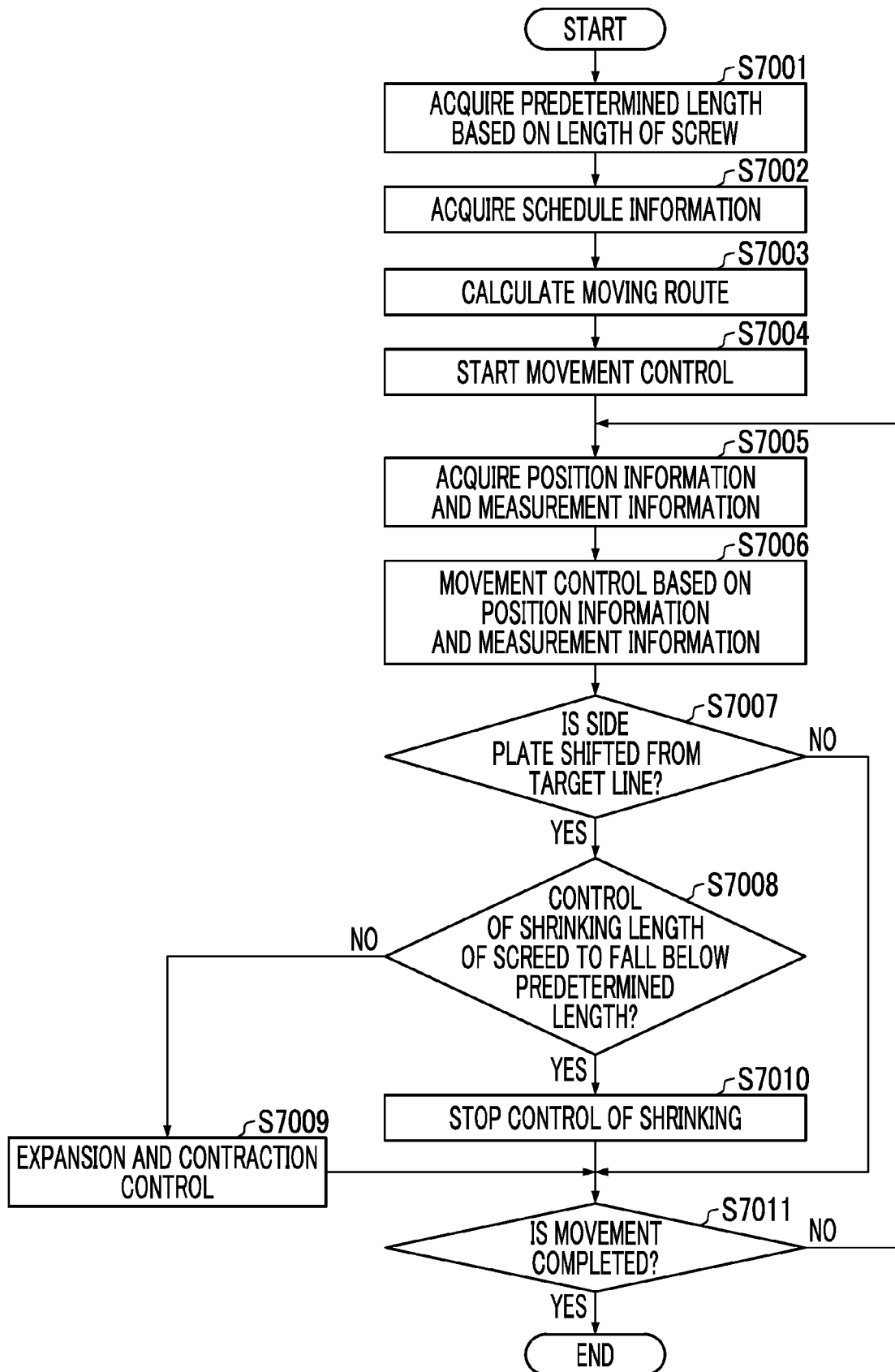
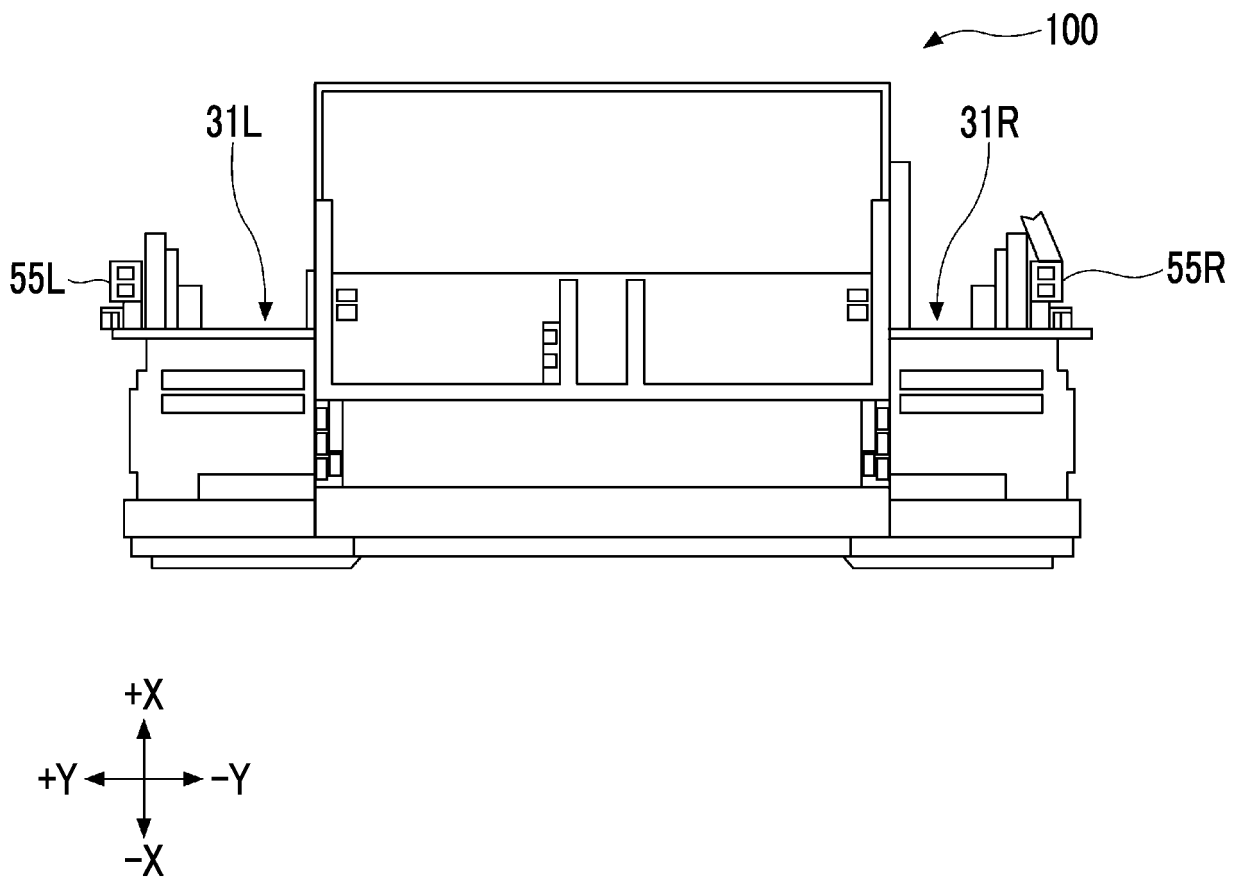


FIG. 8





EUROPEAN SEARCH REPORT

Application Number

EP 23 16 0340

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	JP H04 105108 U (NIIGATA IRON WORKS) 10 September 1992 (1992-09-10) * paragraphs [0004] - [0015]; claim 1; figures *	1-7	INV. E01C19/48 E01C19/00
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TECHNICAL FIELDS
SEARCHED (IPC)

E01C

The present search report has been drawn up for all claims

4

Place of search	Date of completion of the search	Examiner
Munich	21 July 2023	Schultze, Yves
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document		

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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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