(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 4 372 147 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
22.05.2024 Bulletin 2024/21

(21) Application number: **23194129.5**

(22) Date of filing: **30.08.2023**

(51) International Patent Classification (IPC):
E01C 19/48 *(2006.01)*

(52) Cooperative Patent Classification (CPC):
E01C 19/4833; E01C 2301/16

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA
Designated Validation States:
KH MA MD TN

(30) Priority: **18.11.2022 JP 2022184915**

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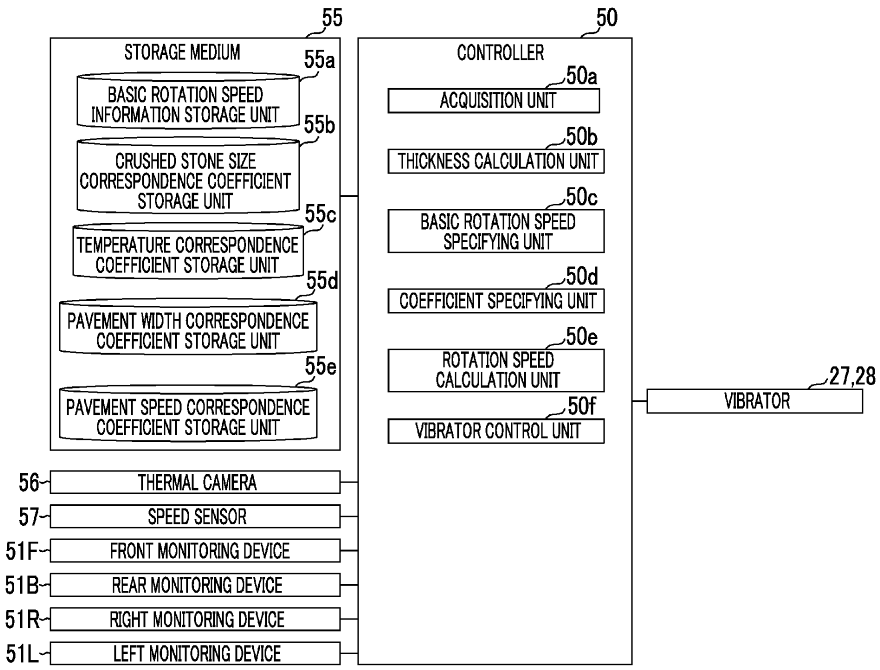
(54) ASPHALT FINISHER

(57) The quality of a pavement surface is improved. According to an aspect of the present invention, there is provided an asphalt finisher (100) including 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 (SC) that spreads the paving material, which is transported by the conveyor (CV) and is sprinkled on a road surface, in a vehicle width direction, a screed device that levels the paving material spread by the screw (SC) on a rear side of the screw (SC), and a vibrator (27, 28) that vibrates the screed device, in which the asphalt finisher (100) is configured to perform control to change a frequency for vibrating the vibrator (27, 28), while construction of leveling the paving material on the road surface is performed.

FIG. 3



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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 levels the paving material on the road surface with a screed, the asphalt finisher compacts the paving material. For example, in the technique described in Japanese Unexamined Patent Publication No. 2021-113490, there is proposed a technique of adjusting compaction performance by controlling the frequency and stroke of the tampers provided in a screed.

SUMMARY OF THE INVENTION

[0004] The screed of the asphalt finisher is provided with a vibrator in addition to the tamper. The asphalt finisher also performs control to vibrate not only the tamper but also the vibrator in order to compact the paving material. The frequency that determines the strength of the vibrator tends to be manually set by the worker in consideration of the thickness of the paving material and the like.

[0005] As described above, in the asphalt finisher, the compaction performance of the tamper is adjusted according to the construction situation, whereas the vibrator only vibrates at a manually set frequency.

[0006] In view of the above, the improvement in the quality of the compacted pavement surface is achieved by changing the frequency for vibrating the vibrators, according to the construction state of the asphalt finisher and appropriately compacting the paving material on the road surface.

[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 is sprinkled on a road surface, in a vehicle width direction, a screed device that levels the paving material spread by the screw on a rear side of the screw, and a vibrator that vibrates the screed device, in which the asphalt finisher is configured to perform control to change a frequency for vibrating the vibrator, while construction of leveling the paving material on the road surface is performed.

[0008] According to one aspect of the present invention, the quality of the compacted pavement surface is improved.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009]

Figs. 1A and 1B are views showing an asphalt finisher which is an example of a road paving machine according to an embodiment.
Fig. 2 is a diagram illustrating an disposition of vibrators according to the embodiment.
Fig. 3 is a block diagram showing a configuration example of a controller and devices connected to the controller according to the embodiment.
Fig. 4 is a cross-sectional view of a newly constructed pavement body according to the embodiment.
Fig. 5 is a diagram conceptually showing a correspondence relationship held by a basic rotation speed information storage unit according to an embodiment.
Fig. 6 is a diagram illustrating a table structure of a crushed stone size correspondence coefficient storage unit used for the paving material according to the embodiment.
Fig. 7 is a diagram illustrating a table structure of a temperature correspondence coefficient storage unit of a paving material according to an embodiment.
Fig. 8 is a diagram illustrating a table structure of a pavement width correspondence coefficient storage unit according to the embodiment.
Fig. 9 is a diagram illustrating a table structure of a pavement speed correspondence coefficient storage unit according

to the embodiment.

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 views showing an asphalt finisher 100 which is an example of a road paving machine according to an embodiment. Specifically, Fig. 1A is a left side view, and Fig. 1B is a top view.

[0012] The asphalt finisher 100 is mainly configured by a tractor 1, a hopper 2, and a screed 3 (an example of a screed device). Hereinafter, a direction of the hopper 2 viewed from the tractor 1 (+X direction) will be referred to as forward, and a direction of the screed 3 viewed from the tractor 1 (-X direction) will be referred to as rearward. The road paving machine may be a base paver, a tack paver, a goose asphalt paver, a multi-asphalt paver, or the like. A compaction degree measuring instrument 8 is further provided behind the asphalt finisher 100 of the present embodiment.

[0013] The tractor 1 is a mechanism for moving the asphalt finisher 100. In the present embodiment, the tractor 1 rotates a rear wheel 5 using a rear wheel traveling hydraulic motor and rotates a front wheel 6 using a front wheel traveling hydraulic motor to move the asphalt finisher 100. The rear wheel traveling hydraulic motor and the front wheel traveling hydraulic motor rotate by receiving supply of a hydraulic oil from a hydraulic pump. The rear wheel 5 and the front wheel 6 may be replaced with a crawler. The traveling motor may be an electric motor.

[0014] The hopper 2 is a mechanism for receiving a paving material. In the present embodiment, the hopper 2 is provided on a front side of the tractor 1 and is configured to be able to be opened and closed in a vehicle width direction (Y-axis direction) by a hopper cylinder. The asphalt finisher 100 usually receives a paving material (for example, an asphalt mixture) from a loading platform of a dump truck when the hopper 2 is in a fully open state. The dump truck is an example of a transport vehicle that transports the paving material. Figs. 1A and 1B show that the hopper 2 is in a fully open state. The hopper 2 is closed when the paving material in the hopper 2 decreases, and the paving material near an inner wall of the hopper 2 is collected at a central portion of the hopper 2. This is to enable a conveyor CV which is at the central portion of the hopper 2 to feed the paving material to the rear side of the tractor 1. The paving material fed to the rear 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. In the present embodiment, the screw SC is in a state where an extension screw is connected right and left. Figs. 1A and Fig. 1B show the paving material PV spread by the screw SC in a dot pattern.

[0015] The screed 3 is a mechanism for leveling the paving material PV spread by the screw SC. In the present embodiment, the screed 3 includes a main screed 30 and a telescopic screed 31 as shown in Fig. 1B. The main screed 30 includes a left main screed 30L and a right main screed 30R. The telescopic screed 31 includes a left telescopic screed 31L and a right telescopic screed 31R. The screed 3 is a floating screed pulled by the tractor 1 and is connected to the tractor 1 via a leveling arm 3A.

[0016] 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 24.

[0017] 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 of a paving material. In the present embodiment, the leveling cylinder 23 has a cylinder portion connected to the tractor 1 and a rod portion connected to a connection portion of the leveling arm 3A with the tractor 1. In a case of increasing the leveling thickness, the 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 leveling arm 3A. On the other hand, in a case of reducing the leveling thickness, the controller 50 causes the 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 leveling arm 3A.

[0018] The screed lift cylinder 24 is a hydraulic cylinder for lifting the screed 3. In the present embodiment, a cylinder portion of the screed lift cylinder 24 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 a hydraulic oil discharged by the hydraulic pump to flow into a rod-side oil chamber of the screed lift cylinder 24. As a result, the screed lift cylinder 24 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 24 to flow out. As a result, the screed lift cylinder 24 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.

[0019] A mold board 43 is attached to a front portion of the screed 3. The mold board 43 is configured to be able to adjust the amount of the paving material PV staying in front of the screed 3. The paving material PV reaches under the screed 3 through a gap between a lower end of the mold board 43 and a roadbed BS.

[0020] The screed 3 is provided with a left front side tamper 25L, a right front side tamper 25R, a left rear side tamper 26L, and a right rear side tamper 26R (hereinafter, collectively referred to as tampers 25 and 26). The left main screed

30L finishes the paving material tamped and compacted by the left front side tamper 25L. The right main screed 30R finishes the paving material tamped and compacted by the right front side tamper 25R. The left telescopic screed 31L finishes the paving material tamped and compacted by the left rear side tamper 26L. The right telescopic screed 31R finishes the paving material tamped and compacted by the right rear side tamper 26R.

[0021] The telescopic screed 31 is configured to expand and contract in the vehicle width direction by a screed telescopic cylinder (not shown). The screed telescopic cylinder is supported by a support portion fixed to a rear surface of a casing of the main screed 30 and is configured to be able to expand and contract the telescopic screed 31 in the vehicle width direction (Y-axis direction). Specifically, the screed telescopic cylinder includes a left screed telescopic cylinder and a right screed telescopic cylinder. The left screed telescopic cylinder 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 telescopic cylinder 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.

[0022] The tampers 25 and 26 move a tamper edge (not shown) up and down through a tamper shaft (not shown) that is partially eccentric by rotation of a motor (not shown) provided in the screed 3. Accordingly, the tampers 25 and 26 tamp the paving material.

[0023] The screed 3 is provided with vibrators 27 and 28 in addition to the tampers 25 and 26.

[0024] Fig. 2 is a diagram illustrating an disposition of vibrators according to the present embodiment. In the disposition example shown in Fig. 2, the tampers 25 and 26 and the like are omitted.

[0025] As shown in Fig. 2, the main screed 30 (left main screed 30L, right main screed 30R), 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. In the present embodiment, for example, 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. In addition, the main screed 30, the left telescopic screed 31L, and the right telescopic screed 31R are not limited to the disposition shown in the present embodiment. That is, the main screed 30, the left telescopic screed 31L, and the right telescopic screed 31R may be in any disposition mode regardless of a well-known disposition mode as long as the construction range in which the paving material is leveled can be adjusted according to the width of the road surface.

[0026] The screed 3 is provided with a left front side vibrator 27L, a right front side vibrator 27R, a left rear side vibrator 28L, and a right rear side vibrator 28R (hereinafter, collectively referred to as vibrators 27 and 28). In the present embodiment, one vibrator 27 is provided in each of the left main screed 30L and the right main screed 30R, and one vibrator 28 is provided in each of the left telescopic screed 31L and the right telescopic screed 31R. The present embodiment shows an example of the disposition of the vibrators 27 and 28, and is not limited to the disposition. For example, a plurality of vibrators may be provided in any one or more of the left main screed 30L, the right main screed 30R, the left telescopic screed 31L, and the right telescopic screed 31R.

[0027] The vibrators 27 and 28 are vibration devices for compacting the paving material. In the present embodiment, the vibrators 27 and 28 are eccentric vibrators driven by motors.

[0028] For example, the right rear side vibrator 28R is provided with a housing 28R2 and a motor 28R1. The rotary shaft of the motor 28R1 is inserted into a keyhole (not shown) provided in the housing 28R2. Accordingly, the rotary shaft of the motor 28R1 is connected to an eccentric shaft (not shown) inside the housing 28R2. Further, the housing 28R2 is bolted to the right telescopic screed 31R by a fastening portion 28R3. Then, in a case where the motor 28R1 rotates the eccentric shaft, vibration is generated in the right rear side vibrator 28R. Since the right rear side vibrator 28R is bolted between the housing 28R2 and the right telescopic screed 31R, the right rear side vibrator 28R can vibrate the entire right telescopic screed 31R.

[0029] Further, the left rear side vibrator 28L is provided with a housing 28L2 and a motor 28L1. The rotary shaft of the motor 28L1 is inserted into a keyhole (not shown) provided in the housing 28L2. Accordingly, the rotary shaft of the motor 28L1 is connected to an eccentric shaft (not shown) inside the housing 28L2. Further, the housing 28L2 is bolted to the left telescopic screed 31L by a fastening portion 28L3. Then, in a case where the motor 28L1 rotates the eccentric shaft, vibration is generated in the left rear side vibrator 28L. Since the left rear side vibrator 28L is bolted between the housing 28L2 and the left telescopic screed 31L, the left rear side vibrator 28L can vibrate the entire left telescopic screed 31L.

[0030] For example, the right front side vibrator 27R is provided with a housing 27R2 and a motor 27R1. The rotary shaft of the motor 27R1 is inserted into a keyhole (not shown) provided in the housing 27R2. Accordingly, the rotary shaft of the motor 27R1 is connected to an eccentric shaft (not shown) inside the housing 27R2. Further, the housing 27R2 is bolted to the right main screed 30R by a fastening portion 27R3. Then, in a case where the motor 27R1 rotates the eccentric shaft, vibration is generated in the right front side vibrator 27R. Since the right front side vibrator 27R is bolted between the housing 27R2 and the right main screed 30R, the right front side vibrator 27R can vibrate the entire right main screed 30R.

[0031] Further, the left front side vibrator 27L is provided with a housing 27L2 and a motor 27L1. The rotary shaft of the motor 27L1 is inserted into a keyhole (not shown) provided in the housing 27L2. Accordingly, the rotary shaft of the motor 27L1 is connected to an eccentric shaft (not shown) inside the housing 27L2. Further, the housing 27L2 is bolted to the left main screed 30L by a fastening portion 27L3. Then, when the motor 27L1 rotates the eccentric shaft, vibration is generated in the left main screed 30L. Since the left front side vibrator 27L is bolted between the housing 27L2 and the left main screed 30L, the left front side vibrator 27L can vibrate the entire left main screed 30L.

[0032] The motors (for example, motors 27R1, 27L1, 28R1, and 28L1) used in the vibrators 27 and 28 may be hydraulic motors or electric motors. Furthermore, a linear vibrator may be applied as the vibrator.

[0033] Then, the left main screed 30L is vibrated by the left front side vibrator 27L, and the right main screed 30R is vibrated by the right front side vibrator 27R. The left telescopic screed 31L is vibrated by the left rear side vibrator 28L, and the right telescopic screed 31R is vibrated by the right rear side vibrator 28R.

[0034] As described above, in the present embodiment, the vibrators 27 and 28 vibrate the screed 3 to compact the paving material. In addition, the frequency for vibrating the vibrators 27 and 28 will be described later.

[0035] Returning to Figs. 1A and 1B, the controller 50 is a control device that controls the asphalt finisher 100. In the present embodiment, the controller 50 is composed of a microcomputer including a CPU, a memory, a non-volatile storage device, and the like, and is mounted on the tractor 1. Each function of the controller 50 is implemented by the CPU executing a program stored in the non-volatile storage device. However, each function of the controller 50 may be configured by hardware or firmware.

[0036] The communication device 53 is configured to be able to control communication between the asphalt finisher 100 and devices outside the asphalt finisher 100. The communication device 53 according to the present embodiment is installed 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.

[0037] A GPS module 54 is an example of a 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 includes 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.

[0038] 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 able to output the acquired information to the controller 50. The space recognition device 51 according to the present embodiment includes a front monitoring device 51F, a rear monitoring device 51B, a right monitoring device 51R, and a left monitoring device 51L.

[0039] The front monitoring device 51F is configured to be able to monitor the front of the asphalt finisher 100. In the present embodiment, the front monitoring device 51F is a LIDAR with a space in front of the tractor 1 as a monitoring range RF, 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.

[0040] The rear monitoring device 51B is configured to be able to monitor the rear of the asphalt finisher 100. In the present embodiment, the rear monitoring device 51B is a LIDAR with the space behind the screed 3 as the monitoring range RB, 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.

[0041] The right monitoring device 51R is configured to be able to monitor the right side of the asphalt finisher 100. In the present embodiment, the right monitoring device 51R is a LIDAR with a space on the right side of the screed 3 as the monitoring range, and may be attached to a guide rail 1G that functions as a handrail for the operator of the asphalt finisher 100 on the rear side of the rear wheel 5.

[0042] The left monitoring device 51L is configured to be able to monitor the left side of the asphalt finisher 100. In the present embodiment, the left monitoring device 51L is a LIDAR that monitors a space on the left side of the screed 3, and may be attached to a guide rail 1G that functions as a handrail for the operator of the asphalt finisher 100 on the rear side of the rear wheel 5.

[0043] The LIDAR measures, for example, a distance between a million or more points within the monitoring range and the LIDAR. However, at least one or more of the front monitoring device 51F, the rear monitoring device 51B, the right monitoring device 51R, and the left monitoring device 51L 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. 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 with reference to the asphalt finisher 100 may be used.

[0044] The monitoring range RF of the front monitoring device 51F includes the roadbed BS before the pavement is performed. 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 the roadbed BS.

[0045] Further, the monitoring range RF of the front monitoring device 51F includes a part of the hopper 2. That is, the front monitoring device 51F can monitor the paving material loaded on the hopper 2.

[0046] The monitoring range RB of the rear monitoring device 51B includes the newly constructed pavement body NP after the pavement is performed. In the present embodiment, the monitoring range RB has a width larger than the width of the newly constructed pavement body NP.

[0047] The monitoring range of the right monitoring device 51R is provided to include the far end portion of the right telescopic screed 31R regardless of the expansion and contraction position in the vehicle width direction.

[0048] The monitoring range of the left monitoring device 51L is provided to include the far end portion of the left telescopic screed 31L regardless of the expansion and contraction position in the vehicle width direction.

[0049] The measurement information detected by the space recognition device 51 according to the present embodiment is transmitted to the controller 50. The controller 50 may automatically steer the asphalt finisher 100 or may notify the driver of an alarm or the like, based on the received measurement information.

[0050] Fig. 3 is a block diagram showing a configuration example of the controller 50 and devices connected to the controller 50. As shown in Fig. 3, the controller 50 includes a non-volatile storage medium 55, and enables read and write control of information stored in the storage medium 55.

[0051] The storage medium 55 includes a basic rotation speed information storage unit 55a, a crushed stone size correspondence coefficient storage unit 55b, a temperature correspondence coefficient storage unit 55c, a pavement width correspondence coefficient storage unit 55d, a pavement speed correspondence coefficient storage unit 55e, and the like. Information stored in each storage unit will be described later.

[0052] The controller 50 is connected to a thermal camera 56, a speed sensor 57, a front monitoring device 51F, a rear monitoring device 51B, a right monitoring device 51R, and a left monitoring device 51L.

[0053] The thermal camera 56 is a camera for detecting the temperature of the paving material. The thermal camera 56 measures the temperature in a non-contact manner by detecting the energy of far infrared rays emitted by the object. The position where the thermal camera 56 is provided may be any position as long as the temperature of the paving material can be detected.

[0054] For example, the thermal camera 56 may be installed to be able to detect the temperature of the paving material after being leveled on the road surface by the screed 3. The temperature detection target of the thermal camera 56 is not limited to the paving material after being leveled on the road surface by the screed 3. For example, the thermal camera 56 may detect the temperature of the paving material spread by the screw SC. As another example, the thermal camera 56 may detect the temperature of the paving material loaded on the hopper 2.

[0055] Further, the present embodiment is not limited to a method using the thermal camera 56 to detect the temperature of the paving material. A temperature sensor may be provided instead of the thermal camera 56. For example, the temperature sensor may detect the temperature of the paving material spread by the screw SC, or may detect the temperature of the paving material loaded on the hopper 2.

[0056] The speed sensor 57 is configured to detect a traveling speed of the asphalt finisher 100. The speed sensor 57 is an encoder that detects the angular speed of the rotary shaft of the rear wheel traveling motor that drives the rear wheels 5. For example, the speed sensor 57 may be configured by a proximity switch or the like that detects a slit formed in a rotating plate.

[0057] Incidentally, in the related art, a worker manually sets a frequency for vibrating the vibrators 27 and 28. In many cases, the leveling thickness of the paving material constructed by the asphalt finisher 100 is locally different from the leveling thickness of the paving material set as the construction plan. Therefore, when the worker manually adjusts the vibrating frequency, it is difficult to set the vibrating frequency corresponding to the leveling thickness.

[0058] On the other hand, in the present embodiment, the controller 50 enables control to change the frequency for vibrating the vibrators 27 and 28, according to the construction situation.

[0059] As described above, the controller 50 according to the present embodiment controls to change the frequency for vibrating the vibrators 27 and 28, while the asphalt finisher 100 performs construction to level paving materials on the road surface.

[0060] The controller 50 according to the present embodiment performs control to change the frequency for vibrating the vibrators 27 and 28, according to the detection results from various types of sensors provided in the asphalt finisher 100 (for example, the thermal camera 56, the speed sensor 57, the front monitoring device 51F, the rear monitoring device 51B, the right monitoring device 51R, and the left monitoring device 51L). That is, the controller 50 according to the present embodiment acquires the situation of the paving material or the asphalt finisher 100 based on the detection results of various types of sensors, and performs control to change the frequencies of the vibrators 27 and 28 based on the acquired situation. The controller 50 according to the present embodiment performs control to change the frequencies of the vibrators 27 and 28 according to the situation of the paving material or the asphalt finisher 100, thereby appropriately compacting the leveled paving material. Therefore, it is possible to improve the quality of the paving material that is leveled.

[0061] In addition, the present embodiment shows an example of changing the frequency for vibrating the vibrators 27 and 28, and is not limited to a method of changing the frequency for vibrating the vibrators 27 and 28, according to the detection results of various types of sensors. For example, the controller 50 may perform control to change the frequency for vibrating the vibrators 27 and 28, according to the data received from the external device or the like.

[0062] For example, the controller 50 can output a signal for changing the rotation speed to the motors 27R1, 27L1, 28R1, and 28L1. As described above, the controller 50 performs control to change the rotation speeds of the motors 27R1, 27L1, 28R1, and 28L1 of the vibrators 27 and 28 as the control to change the frequency for vibrating the vibrators 27 and 28.

[0063] The controller 50 includes, as functional elements, an acquisition unit 50a, a thickness calculation unit 50b, a basic rotation speed specifying unit 50c, a coefficient specifying unit 50d, a rotation speed calculation unit 50e, and a vibrator control unit 50f. In the present embodiment, the above-described functional elements are shown to be distinguished for convenience of description, but do not need to be distinguished physically, and may consist wholly or partially of common software components or hardware components.

[0064] The acquisition unit 50a acquires measurement information from various types of sensors. For example, the acquisition unit 50a acquires measurement information from the front monitoring device 51F, the rear monitoring device 51B, the right monitoring device 51R, and the left monitoring device 51L.

[0065] Further, the acquisition unit 50a acquires a thermographic image from the thermal camera 56. Further, the acquisition unit 50a acquires speed information indicating the traveling speed of the asphalt finisher from the speed sensor 57.

[0066] The thickness calculation unit 50b calculates the leveling thickness of the newly constructed pavement body NP on the road surface. The thickness calculation unit 50b according to the present embodiment calculates the leveling thickness of the newly constructed pavement body NP (leveled paving material) (distance in the vertical direction from the surface of the roadbed BS to the newly constructed pavement body NP), based on the distance in the Z-axis direction of the surface of the roadbed BS with reference to the asphalt finisher 100, indicated by the measurement information from the front monitoring device 51F, and the distance in the Z-axis direction of the surface of the newly constructed pavement body NP with reference to the asphalt finisher 100, indicated by the measurement information from the rear monitoring device 51B.

[0067] Fig. 4 is a cross-sectional view of the newly constructed pavement body NP, and is a view showing a state when a vertical cross section including a one-dot chain line L1 of Fig. 1B is viewed from the + X side.

[0068] In the present embodiment, the front monitoring device 51F is configured to be able to measure the shape of the surface of the roadbed BS before being formed by the asphalt finisher 100.

[0069] On the other hand, the rear monitoring device 51B is configured to be able to measure the finished shape of the surface of the newly constructed pavement body NP formed by the asphalt finisher 100.

[0070] The thickness calculation unit 50b according to the present embodiment converts the coordinates in the local coordinate system indicated by the measurement information from the front monitoring device 51F into the coordinates in the reference coordinate system, thereby specifying each of the coordinates in the reference coordinate system corresponding to each point on the surface of the roadbed LB.

[0071] The thickness calculation unit 50b according to the present embodiment converts the coordinates in the local coordinate system indicated by the measurement information from the rear monitoring device 51B into the coordinates in the reference coordinate system, thereby specifying each of the coordinates in the reference coordinate system corresponding to each point on the surface of the newly constructed pavement body NP.

[0072] First, the thickness calculation unit 50b sets a point on a feature AP that is outside in the width direction of the road surface as a reference point R1.

[0073] In the present embodiment, the reference point R1 is set at the upper end of the L-shaped edge stone that separates the newly constructed pavement body NP However, the feature AP may be a mold used to separate the newly constructed pavement body NP. Further, a point in the air that is not on the feature AP, such as a point vertically above a predetermined height from the upper end of the edge stone, may be set as the reference point R1.

[0074] Specifically, the thickness calculation unit 50b detects the edge stone based on the outputs of the front monitoring device 51F and the rear monitoring device 51B, and sets the upper end of the edge stone that is located at a position separated by a predetermined distance in the -X direction from the rear end of the asphalt finisher 100, as the reference point R1.

[0075] After that, the thickness calculation unit 50b sets a line passing through the reference point R1 and parallel to the width direction (Y-axis direction) of the newly constructed pavement body NP as a virtual water thread VS. The virtual water thread VS is typically a horizontal line passing through the reference point R1.

[0076] After that, the thickness calculation unit 50b derives a vertical distance between the virtual water thread VS and the surface of the newly constructed pavement body NP. In the present embodiment, the thickness calculation unit 50b sets 19 points P1 to P19 at equal intervals on the virtual water thread VS.

[0077] The thickness calculation unit 50b specifies points T1 to T19 on the surface of the roadbed BS that are present immediately below the points P1 to P19, respectively, based on the measurement information of the front monitoring device 51F. Specifically, the thickness calculation unit 50b specifies points T1 to T19, based on the distance between the front monitoring device 51F and each point on the surface of the roadbed BS, which is output by the front monitoring device 51F, and the posture of the front monitoring device 51F.

[0078] After that, the thickness calculation unit 50b calculates the distance Db1 between the point P1 and the point T1. The thickness calculation unit 50b according to the present embodiment calculates the distance Da1 based on the distance between the point P1 and the front monitoring device 51F and the distance between the point T1 and the front monitoring device 51F. The same applies to the distances Da2 to Da19.

[0079] The thickness calculation unit 50b specifies points Q1 to Q19 on the surface of the newly constructed pavement body NP that are present immediately below the points P1 to P19, respectively, based on the measurement information of the rear monitoring device 51B. Specifically, the thickness calculation unit 50b specifies points Q1 to Q19, based on the distance between the rear monitoring device 51B and each point on the surface of the newly constructed pavement body NP, which is output by the rear monitoring device 51B, and the posture of the rear monitoring device 51B.

[0080] After that, the thickness calculation unit 50b calculates the distance Da1 between the point P1 and the point Q1. The thickness calculation unit 50b according to the present embodiment calculates the distance Da1 based on the distance between the point P1 and the front monitoring device 51F and the distance between the point Q1 and the front monitoring device 51F. The same applies to the distances Da2 to Da19.

[0081] The thickness calculation unit 50b calculates the thicknesses D1 to D19 of the newly constructed pavement body NP, based on the distances Da1 to Da19 and the distances Db1 to Db19.

[0082] Specifically, the thickness calculation unit 50b calculates the thickness D1 of the newly constructed pavement body NP by subtracting the distance Db1 from the distance Da1. The same applies to the thicknesses D1 to D19.

[0083] The points set on the virtual water thread VS may be disposed at non-equal intervals. Further, the number of points may be less than 19 or 20 or more.

[0084] The thickness calculation unit 50b calculates the average value of the leveling thickness of the newly constructed pavement body NP, based on the thicknesses D1 to D19. Further, the thickness calculation unit 50b may calculate the unevenness of the surface of the newly constructed pavement body NP, based on the thicknesses D1 to D19.

[0085] The thickness calculation unit 50b according to the present embodiment calculates the leveling thickness of the newly constructed pavement body NP at predetermined time intervals during the construction, that is, during the advancement of the asphalt finisher 100. In addition, the predetermined time may be set according to an embodiment.

[0086] In the present embodiment, an example of calculating the leveling thickness of the newly constructed pavement body NP based on before and after the formation of the newly constructed pavement body NP based on the measurement information of the front monitoring device 51F and the rear monitoring device 51B has been described.

[0087] However, the present embodiment shows an example of a method for calculating the leveling thickness of the newly constructed pavement body NP, and other methods may be used. For example, an ultrasonic sensor may be used instead of the space recognition device 51. As a modification example, it is conceivable to use a plurality of ultrasonic sensors.

[0088] For example, a plate-shaped member provided with a plurality of ultrasonic sensors may be provided in the asphalt finisher 100. The longitudinal direction of the plate-shaped member corresponds to the traveling direction of the asphalt finisher 100. The plate-shaped member includes a first ultrasonic sensor for measuring the distance to the surface of the roadbed BS before the formation of the newly constructed pavement body NP, and a second ultrasonic sensor for measuring a distance to the surface of the newly constructed pavement body NP after the formation of the newly constructed pavement body NP.

[0089] Then, the thickness calculation unit 50b according to the modification example calculates the leveling thickness of the newly constructed pavement body NP, based on the distance to the surface of the roadbed BS measured by the first ultrasonic sensor and the distance to the surface of the newly constructed pavement body NP measured by the second ultrasonic sensor.

[0090] Another method for measuring the leveling thickness of the newly constructed pavement body NP may be used. As a further modification example, the asphalt finisher 100 may be provided with a thickness measuring device for the newly constructed pavement body NP.

[0091] The thickness measuring device of the newly constructed pavement body NP according to the modification example may calculate the difference between the surface of the newly constructed pavement body NP and the surface of the roadbed BS as the leveling thickness of the newly constructed pavement body NP, by outputting the ultrasonic waves reflected on the surface of the newly constructed pavement body NP and the ultrasonic waves reflected on the surface of the roadbed BS. The thickness calculation unit 50b according to the modification example acquires the leveling thickness of the newly constructed pavement body NP, based on the information from the thickness measuring device.

[0092] The basic rotation speed specifying unit 50c acquires the leveling thickness of the newly constructed pavement body NP, calculated by the thickness calculation unit 50b, and specifies the rotation speed (hereinafter, referred to as a basic rotation speed) that is the basis of the motors inside the vibrators 27 and 28, based on the leveling thickness of the newly constructed pavement body NP. In the present embodiment, the basic rotation speed information storage unit 55a is used to specify the basic rotation speed.

[0093] Fig. 5 is a diagram conceptually showing a correspondence relationship held by the basic rotation speed information storage unit 55a according to the present embodiment. In the example shown in Fig. 5, the horizontal axis represents the pavement thickness (the leveling thickness of the newly constructed pavement body NP), and the vertical axis represents the basic rotation speed. In the example shown in Fig. 5, the basic rotation speed corresponding to the pavement thickness is indicated by the line 1501.

[0094] Returning to Fig. 3, the basic rotation speed specifying unit 50c specifies the basic rotation speed Rb corresponding to the acquired leveling thickness of the newly constructed pavement body NP, with reference to the basic rotation speed information storage unit 55a.

[0095] The coefficient specifying unit 50d calculates a coefficient for adjusting the basic rotation speed, based on measurement information from various types of sensors acquired by the acquisition unit 50a.

[0096] For example, when the asphalt finisher 100 compacts the paving material formed as the newly constructed pavement body NP, the degree of compaction by the vibrators 27 and 28 changes depending on the size of the crushed stone contained in the paving material. Therefore, the controller 50 performs control to change the rotation speed of the motors inside the vibrators 27 and 28 based on the size of the crushed stone. Specifically, the coefficient specifying unit 50d acquires the size of the crushed stone contained in the paving material, and specifies the coefficient Ks for adjusting the basic rotation speed, based on the acquired size.

[0097] The coefficient specifying unit 50d according to the present embodiment specifies the maximum size of the crushed stone contained in the paving material, based on the measurement information of the front monitoring device 51F. That is, the coefficient specifying unit 50d specifies the maximum size of the crushed stone contained in the paving material existing in the monitoring target of the front monitoring device 51F.

[0098] The coefficient specifying unit 50d specifies the coefficient Ks corresponding to the maximum size of the specified crushed stone with reference to the crushed stone size correspondence coefficient storage unit 55b.

[0099] Fig. 6 is a diagram illustrating a table structure of the crushed stone size correspondence coefficient storage unit 55b used for the paving material according to the present embodiment. In the example of the table structure shown in Fig. 6, it is shown that the correspondence relationship between the maximum size of the crushed stone contained in the paving material and the coefficient Ks is maintained. For example, it is shown that the coefficient Ks becomes "0.9" when the maximum size of the crushed stone is "0 to 10" mm, the coefficient Ks becomes "1" when the maximum size is "10 to 13" mm, the coefficient Ks becomes "1.1" when the maximum size is "13 to 20" mm, and the coefficient Ks becomes "1.2" when the maximum size is "20 to" mm.

[0100] In addition, the correspondence relationship between the maximum size of the crushed stone and the coefficient Ks shown in Fig. 6 shows an example, and the coefficient Ks may be specified by a correspondence relationship other than the example shown in Fig. 6. Further, in the present embodiment, an example has been described in which as an example of the coefficient corresponding to the size of the crushed stone, the coefficient Ks is specified based on the maximum size of the crushed stone. However, the present embodiment does not limit the coefficient corresponding to the size of the crushed stone to the coefficient Ks corresponding to the maximum size of the crushed stone. That is, the coefficient that is specified based on the size of the crushed stone may be used for adjusting the rotation speed, and the coefficient corresponding to the average size of the crushed stone contained in the paving material may be specified.

[0101] In the present embodiment, an example has been described in which the size of the crushed stone is specified based on the measurement information of the front monitoring device 51F. However, the present embodiment does not limit the information used for specifying the size of the crushed stone to the measurement information. For example, the paving material used in the asphalt finisher 100 is defined by a construction plan. Therefore, the coefficient specifying unit 50d may acquire information on the size of the crushed stone contained in the paving material, from a management server that manages the construction plan, a dump truck, or the like, by using wireless communication or the like.

[0102] When the asphalt finisher 100 compacts the paving material, the degree of compaction by the vibrators 27 and 28 changes depending on the temperature of the paving material. Therefore, the controller 50 according to the present embodiment performs control to change the rotation speed of the motors inside the vibrators 27 and 28 based on the temperature of the paving material. Specifically, the coefficient specifying unit 50d acquires the temperature of the paving material from the thermographic image, and specifies the coefficient Kt for adjusting the basic rotation speed, based on the acquired temperature.

[0103] The coefficient specifying unit 50d according to the present embodiment specifies the temperature of the paving material, based on the thermographic image of the thermal camera 56. The specified temperature may be the average temperature of the paving material or the maximum temperature of the paving material.

[0104] Incidentally, there are a plurality of types of paving materials used for the asphalt finisher 100. For example, the type of the paving material is different from the type of the additive contained in the paving material (asphalt). The additive is related to the viscosity and hardness of the paving material. Therefore, the viscosity or the hardness of the paving material corresponding to the temperature is different depending on the type of the paving material. Therefore, in the present embodiment, the coefficient Kt corresponding to the temperature is made different for each type of paving material.

[0105] Then, the coefficient specifying unit 50d according to the present embodiment acquires the type of the paving material. Any method may be used as the method for acquiring the type of paving material. For example, the coefficient specifying unit 50d may acquire information on the type of the paving material, from a management server that manages the construction plan, a dump truck, or the like, by using wireless communication or the like.

[0106] Then, the coefficient specifying unit 50d specifies the coefficient Kt corresponding to the type of the paving material and the temperature of the paving material with reference to the temperature correspondence coefficient storage unit 55c.

[0107] Fig. 7 is a diagram illustrating a table structure of the temperature correspondence coefficient storage unit 55c of the paving material according to the present embodiment. An example of the table structure shown in Fig. 7 shows that for the paving material A, a correspondence relationship between the temperature of the paving material and the coefficient Kt is maintained. For example, it is shown that the coefficient Kt is "1.2" when the temperature of the paving material is "100"°C or lower, the coefficient Kt is "1.1" when the temperature of the paving material is "100 to 120"°C, the coefficient Kt is "1" when the temperature of the paving material is "120 to 140"°C, the coefficient Kt is "1" when the temperature of the paving material is "140 to 160"°C, and the coefficient Kt is "1" when the temperature of the paving material is "160"°C or higher.

[0108] The temperature correspondence coefficient storage unit 55c stores the correspondence relationship for each of the types of the paving material (for example, the paving material A, the paving material B, and the paving material C) used by the asphalt finisher 100. In addition, the correspondence relationships of the paving materials other than the paving material A are not described on the assumption that only the coefficient associated with the temperature is different.

[0109] Further, in the asphalt finisher 100, the expansion and contraction control of the telescopic screed 31 is performed according to the width of the road surface to be paved. It is preferable to adjust the degree of compaction according to the length of the screed 3 in the vehicle width direction. Therefore, the controller 50 according to the present embodiment performs control to change the rotation speed of the motors inside the vibrators 27 and 28 based on the length of the screed 3 in the vehicle width direction. Specifically, the coefficient specifying unit 50d acquires the length of the screed 3 in the vehicle width direction from the measurement information of the right monitoring device 51R and the left monitoring device 51L, and specifies a coefficient Kl for adjusting the basic rotation speed, based on the acquired length.

[0110] The coefficient specifying unit 50d according to the present embodiment specifies the length of the screed 3, based on the far end portion of the telescopic screed 31 detected in the measurement information of the right monitoring device 51R and the left monitoring device 51L. The monitoring ranges of the right monitoring device 51R and the left monitoring device 51L include a far end portion of the telescopic screed 31. Therefore, the measurement information of the right monitoring device 51R and the left monitoring device 51L includes a distance from each of the right monitoring device 51R and the left monitoring device 51L to the far end portion of the telescopic screed 31. Therefore, the coefficient specifying unit 50d can specify the length of the telescopic screed 31.

[0111] Then, the coefficient specifying unit 50d specifies the coefficient Kl corresponding to the length of the screed 3 with reference to the pavement width correspondence coefficient storage unit 55d.

[0112] Fig. 8 is a diagram illustrating a table structure of the pavement width correspondence coefficient storage unit 55d according to the present embodiment. An example of the table structure shown in Fig. 8 shows that the correspondence relationship between the length of the screed 3 and the coefficient Kl is maintained. For example, it is shown that when the length of the telescopic screed 31 is within the range of the basic width of the screed 3 to "25%" of the stretchable length, the coefficient Kl is "1", when the length of the telescopic screed 31 is within the range of "25% to 50%" of the stretchable length, the coefficient Kl is "1.03", when the length of the telescopic screed 31 is within the range of "50% to 75%" of the stretchable length, the coefficient Kl is "1.06", and when the length of the telescopic screed 31 is within the range of "75% of the stretchable length to the maximum width", the coefficient Kl is "1.1". In the present embodiment, an example in which the length of the screed 3 is indicated by "%" will be described. However, a correspondence relationship between the actual length (unit: meter) of the screed 3 and the coefficient may be maintained.

[0113] In addition, in the present embodiment, an example has been described in which the length of the screed 3 is specified based on the far end portion of the telescopic screed 31 detected in the measurement information of the right monitoring device 51R and the left monitoring device 51L. The present embodiment does not limit the method for specifying the length of the screed 3 to a method using the detection results of the right monitoring device 51R and the left monitoring device 51L. For example, the length of the screed 3 may be specified based on a detection result of a stroke sensor (not shown) provided in the screed telescopic cylinder that expands and contracts the telescopic screed 31.

[0114] As another example, the GPS module may be installed at a far end portion of the telescopic screed 31. Then, the coefficient specifying unit 50d may specify the length of the screed 3, based on the position information received from the GPS module at the far end portion of the telescopic screed 31. Furthermore, a laser sensor may be installed at a far end portion of the telescopic screed 31. Then, the laser sensor may measure the distance to the feature AP which is outside in the width direction of the road surface, and the coefficient specifying unit 50d may specify the length of the screed 3, based on the width of the road surface and the distance to the feature AP. The same applies to the method for specifying the coefficient Kl after specifying the length of the screed 3. In the present embodiment, when the width of the road surface to be constructed changes, the controller 50 adjusts the coefficient Kl according to the length of the screed that is adjusted according to the width of the road surface. Therefore, even when the width of the road surface changes, it is possible to appropriately compact the paving material leveled. Therefore, it is possible to improve the quality of the paving material that is leveled.

[0115] Further, in the asphalt finisher 100, the movement speed is controlled based on a road surface situation or the like. When the movement speed of the asphalt finisher 100 changes, it is preferable to change the frequency at which the vibrators 27 and 28 vibrate, according to the movement speed. Therefore, the controller 50 according to the present embodiment performs control to change the rotation speeds of the motors inside the vibrators 27 and 28 based on the movement speed of the tractor 1. Specifically, the coefficient specifying unit 50d acquires the movement speed of the tractor 1 from the speed sensor 57, and specifies the coefficient Kv for adjusting the basic rotation speed, based on the acquired movement speed.

[0116] The coefficient specifying unit 50d according to the present embodiment acquires the movement speed of the tractor 1, from the speed sensor 57.

[0117] Then, the coefficient specifying unit 50d specifies the coefficient Kv corresponding to the movement speed with reference to the pavement speed correspondence coefficient storage unit 55e.

[0118] Fig. 9 is a diagram illustrating a table structure of the pavement speed correspondence coefficient storage unit 55e according to the present embodiment. An example of the table structure shown in Fig. 9 shows that a correspondence relationship between the movement speed and the coefficient Kv is maintained. For example, it is shown that the coefficient Kv becomes "1" when the movement speed is "3.0" m/min or less, the coefficient Kv becomes "1.03" when the movement speed is "3.0 to 7.0" m/min, the coefficient Kv becomes "1.06" when the movement speed is "7.0 to 10.0" m/min, and the coefficient Kv becomes "1.1" when the movement speed is "10" m/min or more. In the present embodiment, the controller 50 adjusts the coefficient Kv according to the movement speed, when the movement speed of the tractor 1 changes according to the situation of the road surface to be constructed. Therefore, even when the movement speed of the tractor 1 changes depending on the situation of the road surface, it is possible to appropriately compact the paving material leveled. Therefore, it is possible to improve the quality of the paving material that is leveled.

[0119] The rotation speed calculation unit 50e calculates the rotation speed R of the motors inside the vibrators 27 and 28, based on the basic rotation speed Rb specified by the basic rotation speed specifying unit 50c and the coefficients Ks, Kt, Kl, and Kv specified by the coefficient specifying unit 50d. In the present embodiment, the rotation speed R is calculated from the following Equation (1).

$$R = Rb \times Ks \times Kt \times Kl \times Kv \ \ldots\ldots \ (1)$$

[0120] When at least one or more of the coefficients Ks, Kt, Kl, and Kv cannot be specified by the coefficient specifying unit 50d when the rotation speed calculation unit 50e calculates the rotation speed R, the coefficient that cannot be specified (coefficient Ks, Kt, Kl, or Kv) is set to "1", and the rotation speed R is calculated.

[0121] Further, in a case where the thickness calculation unit 50b cannot calculate the leveling thickness of the paving material, the basic rotation speed specifying unit 50c also cannot specify the basic rotation speed. In this case, the rotation speed calculation unit 50e determines the rotation speed R = "2000" rpm. In addition, the rotation speed R in a case where the basic rotation speed cannot be specified is an example, and may be changed to any value. Further, a method of determining the rotation speed R in a case where the leveling thickness of the paving material cannot be calculated is shown as an example, and the basic rotation speed Rb may be determined instead of the rotation speed R.

[0122] The rotation speed R is calculated by the rotation speed calculation unit 50e at predetermined time intervals. In other words, the frequency for vibrating the vibrators 27 and 28 is changed at predetermined time intervals, according to a situation in which the asphalt finisher 100 performs construction. Therefore, the coefficients Ks, Kt, Kl, and Kv and the basic rotation speed Rb used in the calculation of the rotation speed R are also specified at predetermined time intervals. As described above, in the present embodiment, the frequency for vibrating the vibrators 27 and 28 is changed at predetermined time intervals, but the present invention is not limited to the method of changing at predetermined time intervals, and change may be performed at predetermined intervals, for example, at predetermined distances. In the present embodiment, by changing the frequency at predetermined intervals, compaction according to the situation of at least one or more of the asphalt finisher 100, the road surface, and the paving material can be implemented. Therefore, it is possible to improve the quality of the paving material that is leveled.

[0123] In addition, a predetermined interval (for example, a predetermined time, a predetermined distance) for changing the frequency for vibrating may be set by the operator. By adjusting the predetermined interval by the operator, it is possible to easily implement the setting of the vibrating frequency, according to the situation of the road surface or the like.

[0124] The vibrator control unit 50f controls the vibrators 27 and 28 to rotate the internal motors at the rotation speed R calculated by the rotation speed calculation unit 50e.

(Modification Example)

[0125] The above-described embodiment shows an example of the coefficients specified by the coefficient specifying unit 50d, and other coefficients may be used in order to vibrate the vibrators 27 and 28. Therefore, in the modification example, an example in which the frequency for vibrating the vibrators 27 and 28 is changed based on the material contained in the paving material will be described.

[0126] The coefficient specifying unit 50d specifies the coefficients Ks, Kl, and Kv in the same manner as in the above-described embodiment. Further, the coefficient specifying unit 50d according to the present modification example specifies the coefficient Kk. Further, the coefficient specifying unit 50d according to the present modification example specifies the coefficient Kt' corresponding to the temperature of the paving material, by a method different from that of the above-described embodiment.

[0127] When the asphalt finisher 100 compacts the paving material, the degree of compaction by the vibrators 27 and 28 changes depending on the type of the paving material. Therefore, the controller 50 according to the present modification example performs control to change the rotation speed of the motors inside the vibrators 27 and 28 based on the type of the paving material. Specifically, the coefficient specifying unit 50d acquires the type of the paving material, and specifies the coefficient Kk for adjusting the basic rotation speed, based on the acquired type.

[0128] The type of the paving material is different from the type of the additive contained in the paving material (asphalt), as described above.

[0129] The coefficient specifying unit 50d according to the present modification example acquires the type of the paving material. Any method may be used as the method for acquiring the type of paving material. For example, the coefficient specifying unit 50d may acquire information on the type of the paving material, from a management server that manages the construction plan, a dump truck, or the like, by using wireless communication or the like.

[0130] Then, the coefficient specifying unit 50d specifies the coefficient Kk corresponding to the type of the paving material with reference to a type correspondence coefficient storage unit (not shown). In the type correspondence coefficient storage unit, a type of the paving material and a numerical value indicating the coefficient Kk are associated with each other.

[0131] Further, the coefficient specifying unit 50d acquires the temperature of the paving material from the thermographic image taken by the thermal camera 56, and specifies the coefficient Kt' for adjusting the basic rotation speed, based on the acquired temperature.

[0132] The temperature correspondence coefficient storage unit 55c according to the present modification example stores a correspondence relationship between the temperature of the paving material and the coefficient Kt'. The temperature correspondence coefficient storage unit 55c according to the present modification example does not store a correspondence relationship for each type of paving material but stores the correspondence relationship between the temperature of the paving material and the coefficient Kt', regardless of the type of the paving material, as in the above-described embodiment. That is, in the present modification example, since the adjustment of the rotation speed corresponding to the type of the paving material is performed by using the coefficient Kk, it is not necessary to consider the type of the paving material in specifying the coefficient Kt'.

[0133] The rotation speed calculation unit 50e calculates the rotation speed R of the motors inside the vibrators 27 and 28, based on the basic rotation speed Rb specified by the basic rotation speed specifying unit 50c and the coefficients Ks, Kt, Kl, Kv, Kk, and Kt' specified by the coefficient specifying unit 50d. In the present embodiment, the rotation speed R is calculated from the following Equation (2).

$$R = Rb \times Ks \times Kk \times Kt' \times Kl \times Kv \ \ldots\ldots \ (2)$$

[0134] The process to be performed when at least one or more of the coefficients Ks, Kk, Kt, Kl, and Kv cannot be specified by the coefficient specifying unit 50d and when the thickness calculation unit 50b cannot calculate the leveling thickness of the paving material is the same as in the above-described embodiment.

[0135] In the above-described embodiment and modification example, an example of coefficients for adjusting the frequency for vibrating the vibrators 27 and 28 is shown. Other coefficients may be used to adjust the frequency for vibrating the vibrators 27 and 28. Furthermore, the present invention is not limited to a method of using all the coefficients shown in the above-described embodiments and modification example as the coefficients for adjusting the frequency for vibrating the vibrators 27 and 28, and at least one or more coefficients may be used.

<Action>

[0136] In the asphalt finisher 100 according to the above-described embodiment and modification example, the frequency at which the vibrators 27 and 28 vibrate is switched according to a situation during construction. Therefore, the operator does not need to switch the frequency at which the vibrators 27 and 28 vibrate, and thus the burden can be reduced.

[0137] Furthermore, since the frequency at which the vibrators 27 and 28 vibrate is switched according to a situation during construction, the road surface can be appropriately compacted. Therefore, since it is not necessary to perform an operation to adjust the frequency at which the vibrators 27 and 28 vibrate to an appropriate frequency, the road surface can be appropriately constructed, even if the operator is inexperienced.

[0138] Further, in the asphalt finisher 100 according to the above-described embodiment and modification example, the frequency at which the vibrators 27 and 28 vibrate is changed according to the pavement thickness, the road surface width, the movement speed, and the temperature of the paving material which change during the construction. Accordingly, the construction is performed according to the frequency at which the vibrators 27 and 28 vibrate, according to the current situation, so that appropriate compaction can be implemented. Therefore, it is possible to form a road surface having a uniform density of the paving material.

[0139] Since the paving material is leveled at a uniform density, the compaction work by the roller, which is a post-process of the asphalt finisher 100, becomes easy. In other words, it is possible to reduce the work load because the work may be performed evenly on each region, that is, the work is performed a determined number of times on each region included in the road surface.

[0140] Further, since the frequency for vibrating the vibrators 27 and 28 is changed according to the construction situation, the paving material is formed at a uniform density, and thus the flatness can be improved in each of the traveling direction of the road surface and the vehicle width direction (crossing direction). Furthermore, since the variation in the density of the paving material is reduced in each of the traveling direction of the road surface and the vehicle width direction (crossing direction), it is possible to improve the quality of the road surface. Furthermore, it is possible to extend the life of the pavement surface.

[0141] In addition, in the asphalt finisher 100 according to the above-described embodiment and modification example, the frequency at which the vibrators 27 and 28 vibrate is adjusted according to the type of the paving material used in the present construction and the size of the crushed stone contained in the paving material. Therefore, compaction according to the paving material used for the construction can be implemented.

[0142] Although the embodiment of the asphalt finisher has been described hereinbefore, the present invention is not limited to the above embodiment, modification example, or the like, and various modifications and improvements can be made within the scope of the present invention described in claims.

Brief Description of the Reference Symbols

[0143]

100 asphalt finisher
27, 28 vibrator
30 main screed
31 telescopic screed
51F front monitoring device
51B rear monitoring device
51R right monitoring device
51L left monitoring device
55 storage medium
55a basic rotation speed information storage unit
55b crushed stone size correspondence coefficient storage unit
55c temperature correspondence coefficient storage unit
55d pavement width correspondence coefficient storage unit
55e pavement speed correspondence coefficient storage unit
56 thermal camera
57 speed sensor
50 controller
50a acquisition unit
50b thickness calculation unit
50c basic rotation speed specifying unit
50d coefficient specifying unit
50e rotation speed calculation unit
50f vibrator control unit

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 (SC) that spreads the paving material, which is transported by the conveyor (CV) and is sprinkled on a road surface, in a vehicle width direction;
   a screed device that levels the paving material spread by the screw (SC) on a rear side of the screw (SC); and
   a vibrator (27, 28)that vibrates the screed device, wherein
   the asphalt finisher (100) is configured to perform control to change a frequency for vibrating the vibrator (27, 28), while construction of leveling the paving material on the road surface is performed.

2. The asphalt finisher (100) according to claim 1, wherein
   the asphalt finisher (100) is configured to acquire a situation of the paving material leveled on the road surface, and perform control to change the frequency, based on the acquired situation.

3. The asphalt finisher (100) according to claim 2, wherein
   the asphalt finisher (100) is configured to acquire at least one or more of a leveling thickness of the paving material, a size of crushed stone contained in the paving material, a temperature of the paving material, and a type of the paving material, as the situation of the paving material leveled on the road surface.

4. The asphalt finisher (100) according to claim 1 or 2, wherein

   the screed device includes a telescopic screed device that can expand and contract in the vehicle width direction of the asphalt finisher (100), and
   the asphalt finisher (100) is configured to acquire a length in the vehicle width direction of the screed device including the telescopic screed device, and perform control to change the frequency, based on the acquired length.

5. The asphalt finisher (100) according to claim 1 or 2, wherein
   the asphalt finisher (100) is configured to acquire a movement speed by the tractor (1), and perform control to change the frequency, based on the acquired movement speed.

6. The asphalt finisher (100) according to claim 1 or 2, wherein
   the frequency for vibrating the vibrator (27, 28) is changed at predetermined intervals, while the construction of leveling the paving material on the road surface is performed.

FIG. 1A

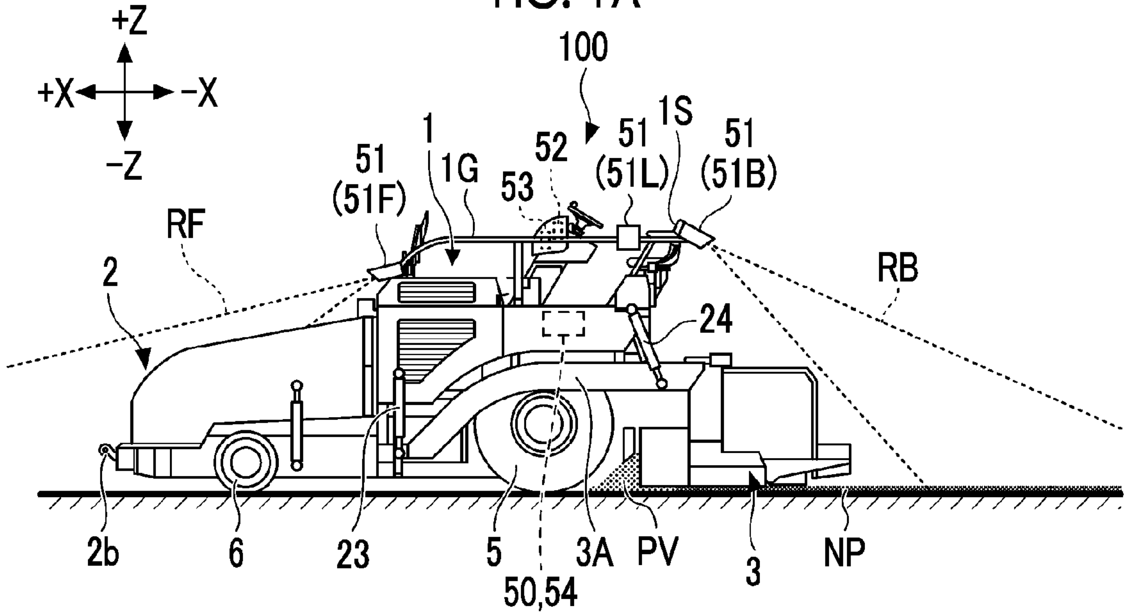

+Z
+X
-X
-Z
100
1
1G
52
53
51
(51F)
51
(51L)
1S
51
(51B)
RF
RB
2
24
2b
6
23
5
3A
PV
3
NP
50,54

FIG. 1B

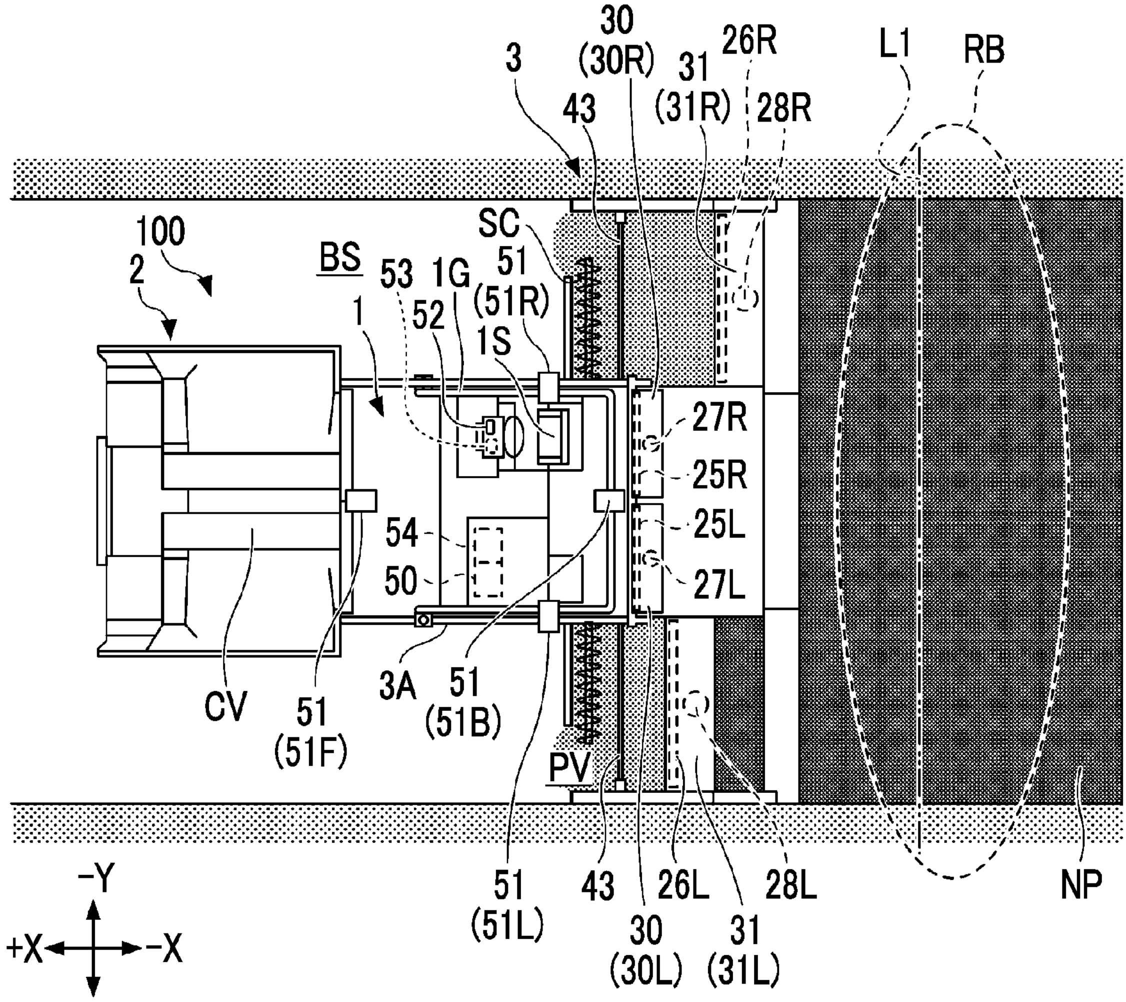

30
(30R)
3
43
31
(31R)
26R
28R
L1
RB
SC
100
2
BS
53
1G
52
51
(51R)
1S
1
27R
25R
25L
54
50
27L
CV
51
(51F)
3A
51
(51B)
PV
51
(51L)
43
26L
28L
NP
30
(30L)
31
(31L)
-Y
+X
-X
+Y

FIG. 2

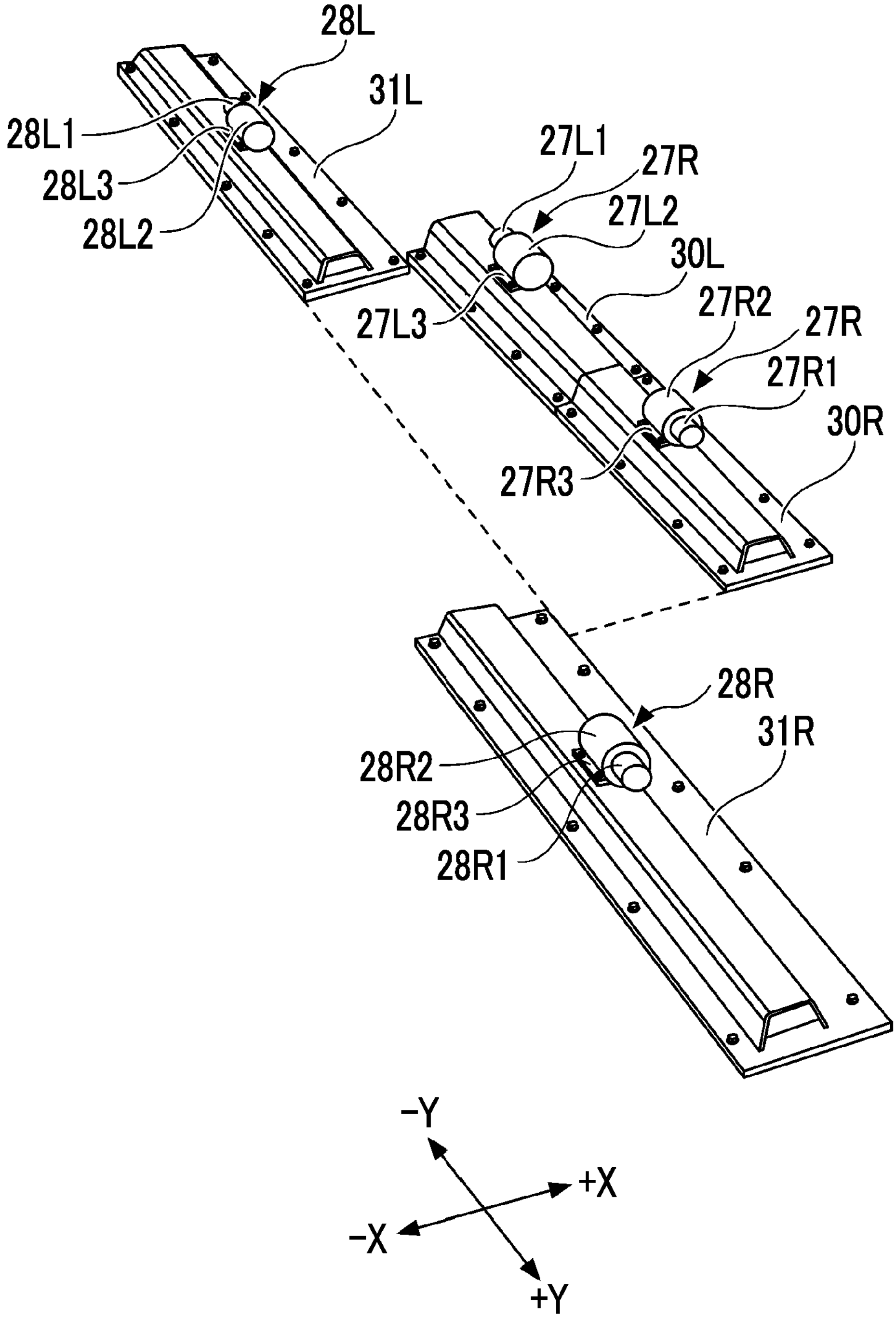

28L
31L
28L1
28L3
28L2
27L1
27R
27L2
30L
27L3
27R2
27R
27R1
30R
27R3
28R
31R
28R2
28R3
28R1
-Y
+X
-X
+Y

FIG. 3

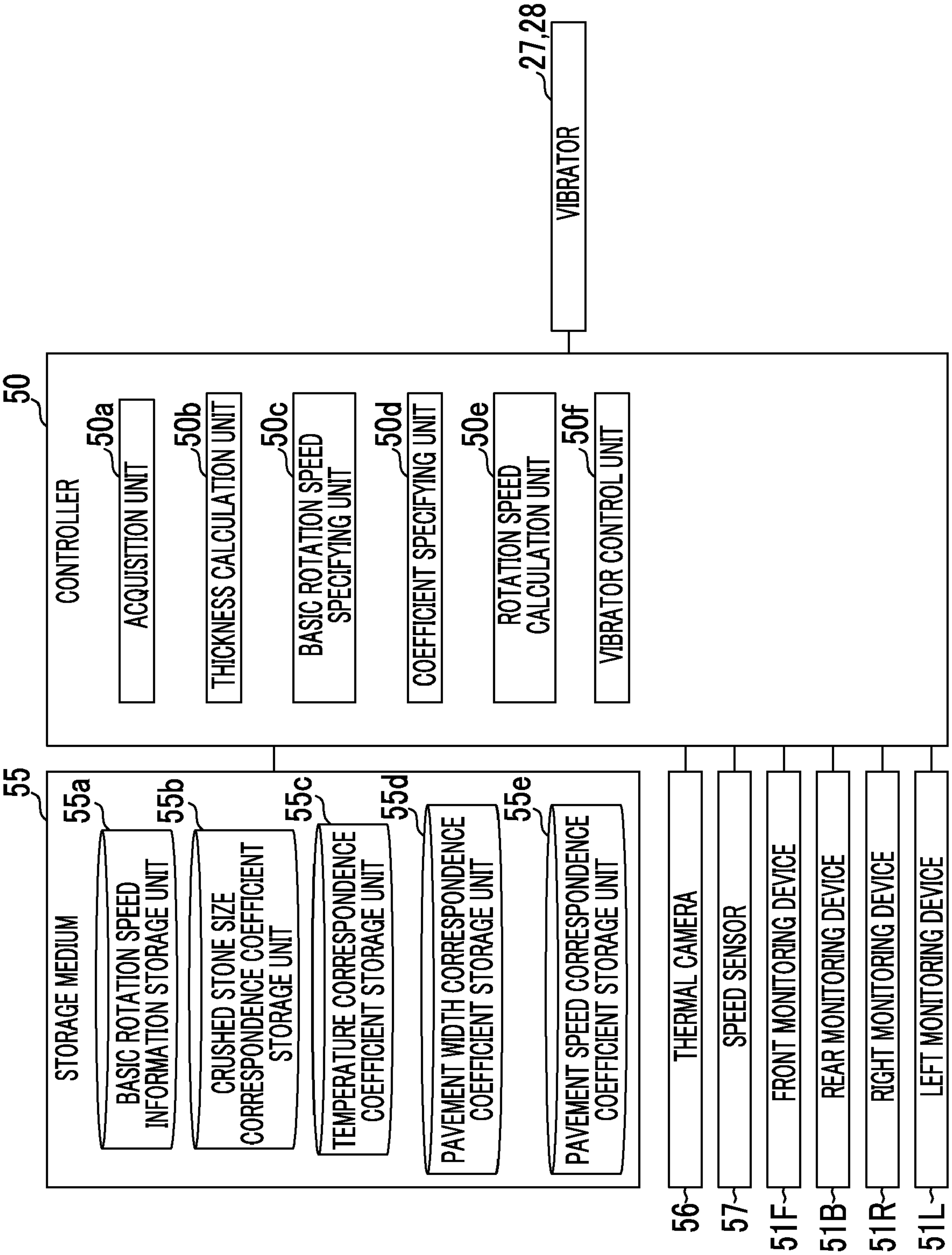
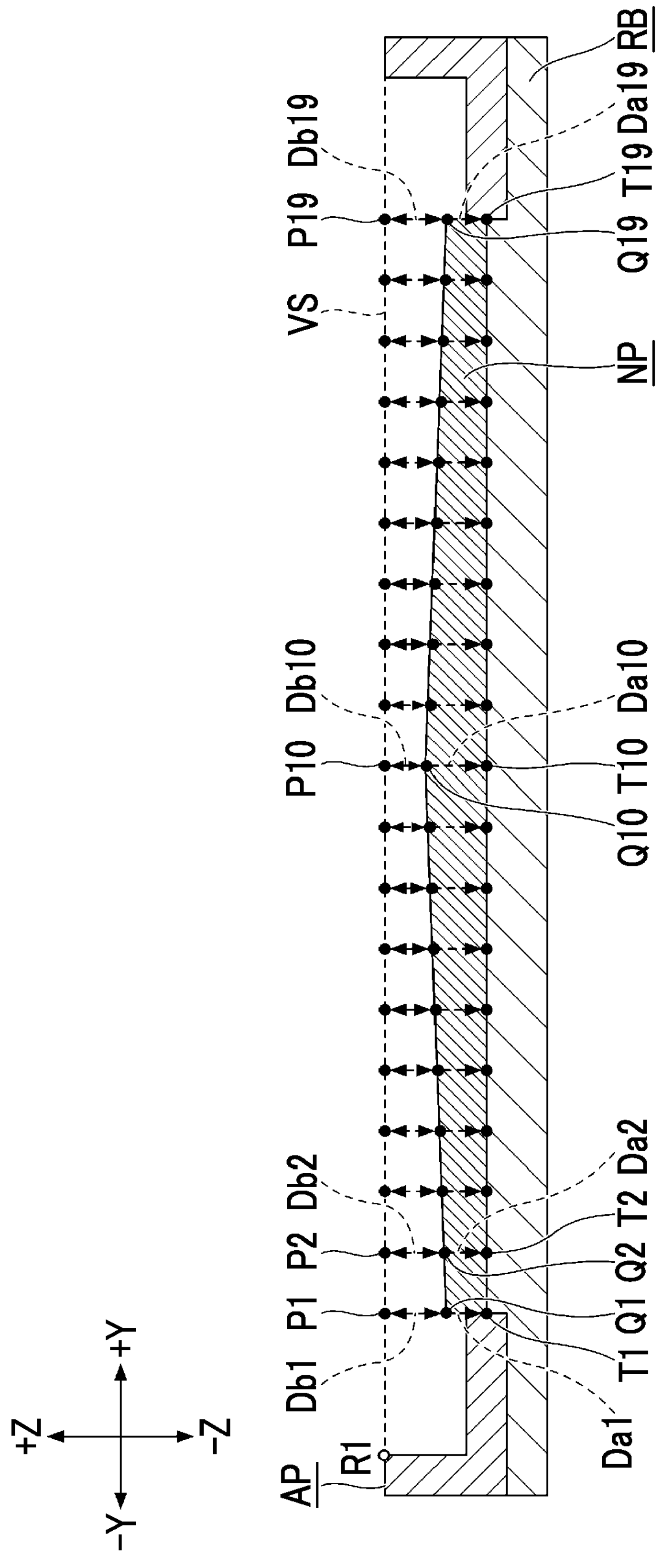

27,28
VIBRATOR
50
CONTROLLER
50a
ACQUISITION UNIT
50b
THICKNESS CALCULATION UNIT
50c
BASIC ROTATION SPEED SPECIFYING UNIT
50d
COEFFICIENT SPECIFYING UNIT
50e
ROTATION SPEED CALCULATION UNIT
50f
VIBRATOR CONTROL UNIT
55
STORAGE MEDIUM
55a
BASIC ROTATION SPEED INFORMATION STORAGE UNIT
55b
CRUSHED STONE SIZE CORRESPONDENCE COEFFICIENT STORAGE UNIT
55c
TEMPERATURE CORRESPONDENCE COEFFICIENT STORAGE UNIT
55d
PAVEMENT WIDTH CORRESPONDENCE COEFFICIENT STORAGE UNIT
55e
PAVEMENT SPEED CORRESPONDENCE COEFFICIENT STORAGE UNIT
56
THERMAL CAMERA
57
SPEED SENSOR
51F
FRONT MONITORING DEVICE
51B
REAR MONITORING DEVICE
51R
RIGHT MONITORING DEVICE
51L
LEFT MONITORING DEVICE

FIG. 4



+Z
-Z
+Y
-Y
AP
R1
Db1
P1
P2
Db2
P10
Db10
VS
P19
Db19
RB
Da19
T19
Q19
NP
Da10
T10
Q10
Da2
T2
Q2
Q1
T1
Da1

FIG. 5

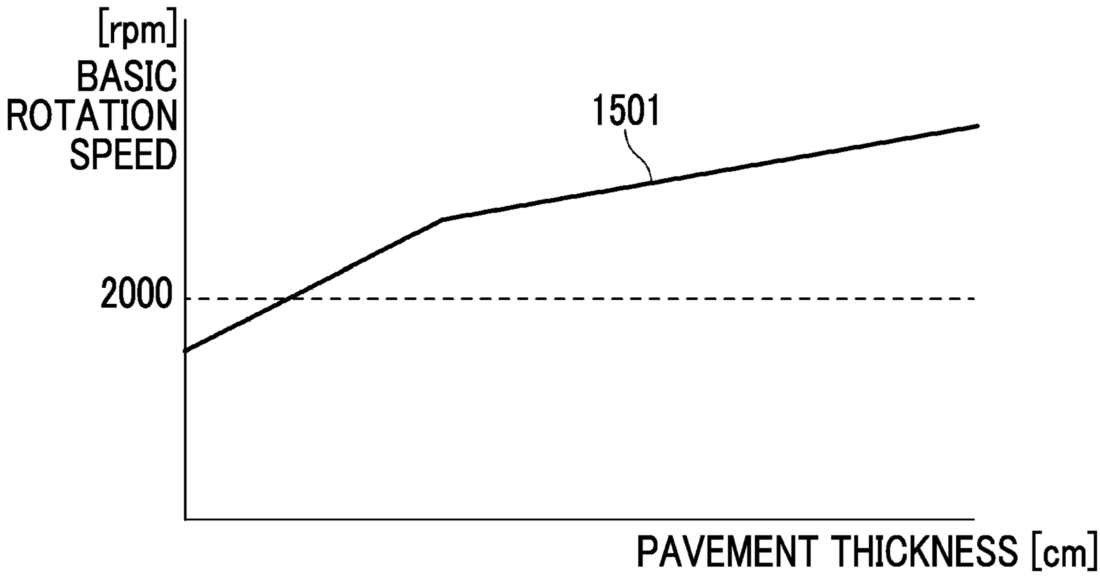


FIG. 6

MAXIMUM PARTICLE SIZE OF CRUSHED STONE	0.9 TO 10	10 TO 13	13 TO 20	20 TO
COEFFICIENT *Ks*	0.9	1	1.1	1.2

UNIT: mm

FIG. 7

PAVING MATERIAL A					
TEMPERATURE	100 OR LOWER	100 TO 120	120 TO 140	140 TO 160	160 OR HIGHER
COEFFICIENT *Kt*	1.2	1.1	1	1	1

UNIT: °C

FIG. 8

SCREED LENGTH	BASIC WIDTH TO 25%	25% TO 50%	50% TO 75%	75% TO MAXIMUM WIDTH
COEFFICIENT Kl	1	1.03	1.06	1.1

UNIT: %

FIG. 9

SPEED	3.0 OR LESS	3.0 TO 7.0	7.0 TO 10.0	10.0 OR MORE
COEFFICIENT Kv	1	1.03	1.06	1.1

UNIT: m/min

Europäisches Patentamt
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EUROPEAN SEARCH REPORT

Application Number
EP 23 19 4129

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	7 February 2024	Kerouach, May

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