

DESCRIPTION

Title of Invention

CONCRETE FINISHING DEVICE

5 Technical Field

[0001] The present disclosure relates to a concrete finishing device.

Background Art

[0002] Patent Literature 1 discloses a concrete floor finishing machine. The concrete floor finishing machine has a finishing device attached to a traveling vehicle. The concrete floor finishing machine finishes a concrete floor surface by rotating the finishing device around the traveling vehicle.

Citation List

Patent Literature

15 [0003] Patent Literature 1: Japanese Unexamined Patent Publication No. S61-270455

Summary of Invention

Technical Problem

[0004] Labor-saving surface finishing work (hereinafter, simply referred to as "finishing work") has been studied in the field. For example, certain finishing devices replace work that a worker performs by using a wooden trowel (wood trowel) or a metallic trowel (metal trowel) by means of a rotationally driven finishing mechanism. Some of such finishing devices are moved by a worker. Further, a self-traveling finishing device (Patent Literature 1) provided with a traveling unit without being moved by a worker has also been studied

from the viewpoint of labor saving.

[0005] The finishing device disclosed in Patent Literature 1 has a finishing unit, a traveling unit, and a unit for driving the finishing unit and the traveling unit. Accordingly, the device is increased in size.

5 As a result, a lifting machine such as a crane is required when the finishing device is brought into a work site and when the finishing device is removed from a work site. Accordingly, the workload required for the finishing device transport increases.

[0006] The present disclosure describes an easily transportable concrete
10 finishing device.

Solution to Problem

[0007] A concrete finishing device that is one form of the present disclosure includes a traveling unit having an endless track provided on a frame, an electrical power source unit mounted to the frame and
15 supplying electrical power to the traveling unit, a finishing unit coupled to the frame of the traveling unit or the electrical power source unit and finishing a concrete surface with a finishing mechanism rotating while in contact with the concrete surface, a first coupling unit removably coupling the finishing unit to the frame of the traveling unit or the
20 electrical power source unit, and a second coupling unit removably coupling the electrical power source unit to the frame of the traveling unit.

[0008] The concrete finishing device has the traveling unit, the finishing unit, and the electrical power source unit. The finishing unit
25 is coupled to the frame of the traveling unit or the electrical power source unit via the first coupling unit. The electrical power source unit

is coupled to the frame of the traveling unit via the second coupling unit. The first coupling unit removably couples the finishing unit to the frame. Alternatively, the first coupling unit removably couples the finishing unit to the electrical power source unit. Further, the second coupling unit removably couples the electrical power source unit to the frame. As a result, the concrete finishing device can be disassembled into the traveling unit, the finishing unit, and the electrical power source unit. Each unit is lighter in weight than the concrete finishing device that is integrated. Accordingly, the concrete finishing device can be easily transported.

[0009] The first coupling unit may removably couple the finishing unit to the frame of the traveling unit. According to this configuration, the traveling unit is capable of suitably pulling the finishing unit.

[0010] The concrete finishing device may further include a sensor unit obtaining information related to a state of the concrete surface and a control unit generating a control signal for at least one of the traveling unit and the finishing unit by using the information obtained by the sensor unit. According to this configuration, the control signal for the traveling unit and the finishing unit is generated in accordance with the state of the concrete surface. As a result, the concrete surface can be finished into a satisfactory state.

[0011] The finishing mechanism may have a blade rotating while in contact with the concrete surface, a rotary shaft to which the blade is coupled, and a blade motor driving the rotary shaft. The blade may be configured to be removable from the rotary shaft. According to these configurations, the concrete surface can be finished into a further

satisfactory state.

[0012] The control unit may control at least one of a movement speed of the traveling unit, a rotation speed of the blade, and a blade angle of the blade with respect to the concrete surface. According to this configuration, at least one of the movement speed of the traveling unit, the rotation speed of the blade, and the blade angle is controlled. As a result, the concrete surface can be finished into a satisfactory state.

[0013] The control unit may have a leveling situation acquisition unit obtaining information related to a leveling situation of the concrete surface by using at least one of a movement speed of the traveling unit, a movement trajectory of the blade, a rotation speed of the blade, and a blade angle of the blade with respect to the concrete surface. The control unit may generate the control signal by using the information obtained by the leveling situation acquisition unit. According to this configuration, the operation of at least one of the traveling unit and the finishing unit is controlled in accordance with the movement speed of the traveling unit, the movement trajectory of the blade, and the rotation speed. As a result, the concrete surface can be finished into a more satisfactory state.

[0014] The sensor unit may have a surface sensor acquiring at least one of information related to smoothness of the concrete surface and information related to a degree of curing of the concrete surface as information related to the state of the concrete surface. The control unit may generate the control signal by using the information obtained by the surface sensor. According to this configuration, the control signal is generated in accordance with the smoothness of the concrete

surface and the degree of curing of the concrete surface. As a result, the concrete surface can be finished into a more satisfactory state.

[0015] The sensor unit may further have an obstacle detection sensor detecting an obstacle present such that a movement by the traveling unit is hindered on the concrete surface. The obstacle detection sensor may include a contact sensor detecting the obstacle by contact with the obstacle and a non-contact sensor detecting the obstacle without contact by emitting a transmission wave to the obstacle and using a reflected wave from the obstacle. According to these configurations, the concrete finishing device can be moved in accordance with the state of a work region. As a result, it is possible to suitably apply the concrete finishing device even in a work region where an obstacle is present.

[0016] The finishing mechanism may be a cylinder member in which a contact portion coming into contact with the concrete surface has an air gap. The finishing device rotates around the rotation axis of the cylinder member as the traveling unit travels. The concrete surface is leveled as a result. Also with this configuration, it is possible to finish the concrete surface into a satisfactory state.

[0017] The finishing mechanism may include a first blade in which a contact portion coming into contact with the concrete surface is flexible and a second blade in which a contact portion coming into contact with the concrete surface is higher in rigidity than the first blade and the contact portion has a convex surface-shaped surface. The first blade and the second blade may be selectively mounted onto the finishing mechanism in accordance with content of finishing work. Also with this configuration, it is possible to finish the concrete surface into a

satisfactory state.

[0018] The first coupling unit may have an elastic member having flexibility along a vertical direction and be deformed in the vertical direction by a weight of the finishing unit. According to this configuration, the first coupling unit allows a relative movement of the finishing unit with respect to the traveling unit. The direction of this movement is the vertical direction. As a result, the first coupling unit is deformed in a case where there is a height difference between the surface on which the traveling unit travels and the surface finished by the finishing unit. As a result, it is possible to absorb the height difference. Accordingly, the first coupling unit allows the finishing unit to move in the vertical direction, and thus the finishing unit is capable of following the concrete surface. Accordingly, a uniform pressure can be applied to the concrete surface.

[0019] The traveling unit may be electrically connected to the electrical power source unit and the endless track may be driven by a first motor performing driving by using electrical power supplied from the electrical power source unit. The finishing unit may be electrically connected to the electrical power source unit and the finishing mechanism may be driven by a second motor performing driving by using electrical power supplied from the electrical power source unit. In a device adopting an external electrical power supply method, electrical power source cable preparation work and electrical power source cable disposition work are required. However, the concrete finishing device does not require external electrical power supply according to this configuration. Accordingly, electrical power source

cable preparation work and electrical power source cable disposition work do not occur in the concrete finishing device. Accordingly, the concrete finishing device can be easily applied to finishing work.

[0020] The traveling unit may have a concrete adhesion suppression unit suppressing adhesion of the concrete to a contact surface of the endless track coming into contact with the concrete surface. The concrete adhesion suppression unit may supply an adhesion suppression substance to the contact surface. According to these configurations, concrete adhesion to the endless track is suppressed. As a result, slipping of the endless track with respect to the concrete surface is suppressed. Accordingly, it is possible to reduce a deviation from the movement trajectory.

Advantageous Effects of Invention

[0021] The concrete finishing device of the present disclosure can be easily transported.

Brief Description of Drawings

[0022] FIG. 1 is a perspective view of a concrete finishing device according to an embodiment.

FIG. 2 is an exploded perspective view of the concrete finishing device according to the embodiment as viewed from another viewpoint.

FIG. 3 is an enlarged view illustrating the shape of a belt.

FIG. 4 is an exploded perspective view of a trowel coupling unit.

FIG. 5 is a functional block diagram for describing the concrete finishing device.

FIG. 6 is a perspective view illustrating a flaking unit.

FIG. 7 is a perspective view illustrating a modification example

of the flaking unit.

Description of Embodiments

[0023] Hereinafter, a concrete finishing device of the present disclosure will be described in detail with reference to the accompanying drawings.

5 In the description of the drawings, the same elements will be denoted by the same reference symbols without redundant description.

[0024] When a concrete surface is finished, so-called leveling work is performed first on placed concrete. As a result, a rough horizontal surface is formed. Next, the concrete is left as it is until the concrete is
10 put into a state called medium tightening. Next, unevenness adjustment work is performed after the medium tightening is confirmed. The unevenness adjustment work is work for eliminating unevenness remaining on the surface. Subsequently, so-called flaking work is performed. During the flaking work, mortar containing fine particles
15 emerges on the concrete surface. A smooth surface can be formed as a result of the flaking work. In the following description, the finishing work includes the unevenness adjustment work and the flaking work.

[0025] A concrete finishing device 1 illustrated in FIG. 1 finishes the surface of a concrete floor that is yet to be cured after placement. The
20 concrete finishing device 1 performs the finishing work including the above-described unevenness adjustment work and flaking work.

[0026] The concrete finishing device 1 mechanically and autonomously performs the finishing work in a preset work region. Specifically, the concrete finishing device 1 calculates a movement trajectory on the
25 basis of prior information. The prior information is, for example, the longitudinal and lateral dimensions of the work region. Then, the

concrete finishing device 1 autonomously moves along the movement trajectory. Accordingly, when the unevenness adjustment work and the flaking work are performed by means of the concrete finishing device 1, the work to be performed by a worker is prior information input by means of an operation terminal 10 (see FIG. 5) such as a tablet computer. The unevenness adjustment work and the flaking work that are subsequently performed can be left to the autonomous operation of the concrete finishing device 1. The worker may perform work such as monitoring and manual operation as needed. As a result, the load on the worker required for the work is significantly reduced.

[0027] As illustrated in FIG. 1, the concrete finishing device 1 has a crawler frame 2 (traveling unit), a trowel frame 3 (finishing unit), and an electrical equipment frame 4 (electrical power source unit) as main components. The trowel frame 3 is removably attached to the crawler frame 2 by a trowel coupling unit 6 (first coupling unit, see FIG. 2). The electrical equipment frame 4 is removably attached to the crawler frame 2 by an electrical equipment frame coupling unit 7 (second coupling unit). The concrete finishing device 1 can be disassembled into the three parts of the crawler frame 2, the trowel frame 3, and the electrical equipment frame 4 as needed.

[0028] <Crawler Frame>

The crawler frame 2 is the base of the concrete finishing device 1. In addition, the crawler frame 2 pulls the trowel frame 3. The crawler frame 2 has a frame 8, a bumper 9, and crawler units 11A and 11B.

[0029] As illustrated in FIG. 2, the shape of the frame 8 is a rectangular

frame shape in a plan view. The bumper 9, the crawler units 11A and 11B, the electrical equipment frame 4, and the trowel frame 3 are attached to the frame 8. The bumper 9 is attached to one long side of the frame 8. The side where the bumper 9 is attached is the front (traveling direction) of the concrete finishing device 1. The trowel frame 3 is attached to the other long side of the frame 8. The side where the trowel frame 3 is attached is the rear of the concrete finishing device 1. The crawler units 11A and 11B are respectively attached to the pair of short sides of the frame 8. The electrical equipment frame 4 is attached to the middle portion of the frame 8. In other words, the electrical equipment frame 4 is attached between the crawler units 11.

[0030] The bumper 9 constitutes the outermost edge portion in the front of the concrete finishing device 1 in a plan view of the concrete finishing device 1. The bumper 9 may constitute the outermost edge portions in the left front and right front of the concrete finishing device 1 in addition to the outermost edge portion in the front. For example, in a case where the concrete finishing device 1 moves forward and any obstacle is present in the traveling direction, the obstacle comes into contact with the bumper 9. Accordingly, the bumper 9 has a contact sensor 37a (see FIG. 5) detecting contact with an obstacle. The concrete finishing device 1 may update the movement trajectory by using the output of the contact sensor 37a.

[0031] The crawler units 11A and 11B (endless tracks) have a belt 12, a motor 13 (first motor, see FIG. 5), and a water sprinkling device 14 (concrete adhesion suppression unit). The belt 12 and the motor 13 are the traveling mechanisms of the concrete finishing device 1. The pair

of crawler units 11A and 11B independently control the rotation direction and rotation speed of the belt 12. The rotation angle and rotation speed of the motor 13 are obtained by a motor sensor 13a (traveling sensor, see FIG. 5). The rotation angle and rotation speed of the motor 13 may be defined as the movement speed of the crawler unit 11. The motor sensor 13a is, for example, a rotary encoder provided on the rotary shaft of the motor 13.

[0032] It is possible to increase the grounding area with respect to a concrete surface S with the crawler units 11A and 11B adopting the belt 12. For example, a tire method and a crawler method are compared as traveling methods. The grounding area of the crawler method is larger than the grounding area of the tire method. Accordingly, the grounding pressure of the crawler method with respect to the concrete surface S is smaller than the grounding pressure of the tire method. As a result, the concrete finishing device 1 adopting the crawler method is capable of initiating the finishing work even in a state where the concrete surface S is relatively soft. Accordingly, the concrete finishing device 1 adopting the crawler method is capable of initiating the finishing work earlier than a finishing device adopting the tire method.

[0033] The belt 12 has a convex shape with respect to the concrete surface S when viewed from the front (see FIG. 3). In other words, the middle part of the belt 12 mainly comes into contact with the concrete surface S. An edge 12a of the belt 12 may be slightly separated from the concrete surface S. According to this configuration, contact of the edge 12a with the concrete surface S is suppressed when the concrete

finishing device 1 changes direction. Accordingly, the concrete surface S can be protected after the finishing.

[0034] The water sprinkling device 14 suppresses concrete adhesion to the surface of the belt 12. Specifically, the water sprinkling device 14 supplies water as an adhesion suppression substance to the surface of the belt 12 that comes into contact with the concrete surface. The water sprinkling device 14 may, for example, always supply the water during the finishing work. The water sprinkling device 14 may control the supply and stop by a control signal output from a control device 33.

When a moisture film is formed on the surface of the belt 12, concrete adhesion to the belt 12 is suppressed by the moisture film. For example, a spray method may be adopted as the water sprinkling device 14. Concrete adhesion to the belt 12 is suppressed according to this configuration. As a result, slipping of the belt 12 with respect to the concrete surface S is suppressed. Accordingly, it is possible to reduce a deviation of the concrete finishing device 1 from the movement trajectory.

[0035] It should be noted that the adhesion suppression substance provided by the water sprinkling device 14 is not limited to water. For example, the adhesion suppression substance may be a drug, a paste substance, foam, or the like.

[0036] <Trowel Frame>

The trowel frame 3 has a blade motor 15 (second motor), two sets of blade units 16A and 16B (finishing mechanisms), and a bumper 17. The blade motor 15 generates torque rotating the blade units 16A and 16B on the basis of a control signal and a driving current provided

from the electrical equipment frame 4. By the blade units 16A and 16B being driven by the blade motor 15, the noise thereof can be significantly reduced as compared with, for example, engine-based driving. As a result, a countermeasure to noise around a work site can be simplified.

[0037] The blade units 16A and 16B have a shaft 18 and a blade 19. The shaft 18 rotates by receiving the torque provided from the blade motor 15. Three blades 19 are coupled to the lower end of the shaft 18. The three blades 19 are at equal intervals. For example, the three blades 19 have an interval of 120 degrees. The proximal end of the blade 19 is easily removable from the shaft 18. Specifically, the blade 19 is attached to a rotor attached to the lower end of the shaft 18. The blade 19 is coupled to the rotor by a rod-shaped coupling tool.

[0038] The bumper 17 surrounds the range in which the blade 19 rotates in a plan view. The bumper 17 constitutes the outermost edge portion in the rear of the concrete finishing device 1. The bumper 17 may have a contact sensor as in the case of the bumper 9.

[0039] <Trowel Coupling Unit>

The trowel coupling unit 6 removably couples the trowel frame 3 to the crawler frame 2. The trowel coupling unit 6 is configured by a plurality of components provided in the crawler unit 11 and the trowel frame 3. The trowel coupling unit 6 transmits the forward driving force of the crawler unit 11 to the trowel frame 3. The crawler unit 11 pulls the trowel frame 3. The trowel coupling unit 6 couples the trowel frame 3 to the crawler frame 2 such that the relative positional relationship between the crawler frame 2 and the trowel frame 3 can be

changed. In other words, the trowel coupling unit 6 couples the trowel frame 3 to the crawler unit 11 while having a certain degree of freedom.

[0040] Specifically, the trowel frame 3 is allowed to move relative to the crawler frame 2 in a vertical direction V and a horizontal direction H.

5 For example, a case is assumed where there is a height difference between the concrete surface S on which the belt 12 of the crawler frame 2 travels and the concrete surface S finished by the trowel frame 3. When the trowel frame 3 is coupled to the crawler frame 2 not via the trowel coupling unit 6, a gap may be generated between the trowel frame 3 and the concrete surface S. On the other hand, the trowel coupling unit 6 allows a relative movement. Accordingly, the trowel frame 3 is capable of moving in the vertical direction V and following the concrete surface S. As a result, the trowel frame 3 is capable of applying a uniform pressure to the concrete surface S.

10 [0041] As illustrated in FIG. 4, the trowel coupling unit 6 has a guide 20, coupling plates 21 and 22, four spring units 23A, 23B, 23C, and 23D, and a snap lock 24.

[0042] The guide 20 positions the trowel frame 3 with respect to the crawler frame 2. The guide 20 includes a pair of guide holes 26a, a guide hole 22a, and a pin 28. The pair of guide holes 26a are provided in a coupling unit 26 of the crawler frame 2. The guide hole 22a is provided in the coupling plate 22. The pin 28 is inserted through the guide holes 22a and 26a.

20 [0043] The coupling plates 21 and 22 are a pair of plate materials. The first coupling plate 21 is fixed to the trowel frame 3. The second coupling plate 22 is coupled to the first coupling plate 21 via the spring

units 23A, 23B, 23C, and 23D. The second coupling plate 22 is provided with the guide hole 22a.

[0044] The spring units 23A, 23B, 23C, and 23D are disposed at different positions. Specifically, the spring units 23A and 23B are fixed to the coupling plates 21 and 22 such that the axes of the spring units 23A and 23B are parallel to the vertical direction. The spring units 23C and 23D are fixed to the coupling plates 21 and 22 such that the axes of the spring units 23C and 23D are parallel to the horizontal direction. Accordingly, in a plan view, the spring units 23A, 23B, 23C, and 23D are disposed so as to form a rectangular shape. As a result of this disposition, it is possible to suitably allow vertical and horizontal deviations. It should be noted that the disposition of the spring units 23A, 23B, 23C, and 23D may appropriately vary with the configuration thereof.

[0045] The spring units 23A, 23B, 23C, and 23D have a common single-unit configuration. Hereinafter, the spring unit 23A will be described in detail. The spring unit 23A has a wire spring 23a (elastic member) and a pair of bases 23b. A wire spring 29a is formed by a wire that has a predetermined rigidity being spirally and plastically deformed. A wire rope vibration-proof material or the like can be used for the wire spring 23a. The wire spring 23a is sandwiched between the pair of bases 23b.

[0046] The spring unit 23A exhibits elasticity along axial and radial directions. For example, the spring unit 23A is deformable with respect to a force to crush or pull a ring along the radial direction. The spring unit 23A is deformable with respect to a shearing force along the

axis. In other words, the spring unit 23A is vertically deformed when one of the coupling plates 21 and 22 vertically deviates with respect to the other. A deviation is allowed as a result.

[0047] A pair of the snap locks 24 have a lever 24a and a projection 24b.

5 The lever 24a is provided on the coupling plate 22. The projection 24b is provided on the coupling unit 26 of the frame 8. The snap lock 24 is capable of easily switching between a state where the trowel frame 3 is coupled to the crawler frame 2 and a state (release state) where the trowel frame 3 is not coupled to the crawler frame 2. Accordingly, the
10 trowel frame 3 can be easily attached to the crawler frame 2. Further, the trowel frame 3 can be easily removed from the crawler frame 2.

[0048] The coupling plates 21 and 22 and the spring unit 23 constitute a main part of the trowel coupling unit 6. In the present embodiment, an example in which the main part is provided on the trowel frame 3 side
15 has been described. Alternatively, the crawler frame 2 may be provided with the main part.

[0049] <Electrical Equipment Frame>

As illustrated in FIG. 5, the electrical equipment frame 4 has an electrical power source device 31, a sensor device 32 (sensor unit), and
20 the control device 33 (control unit).

[0050] The electrical power source device 31 has a battery 34 and an electrical power conversion circuit 36. The battery 34 is, for example, a lithium-ion battery. The electrical power conversion circuit 36 is a so-called inverter circuit. The electrical power conversion circuit 36
25 converts a direct current provided from the battery 34 into an alternating current for the crawler frame 2 and the trowel frame 3. The electrical

power source device 31 is electrically connected to the crawler frame 2. The electrical power source device 31 provides the alternating current for the crawler frame 2. The electrical power source device 31 is electrically connected to the trowel frame 3. The electrical power source device 31 provides the alternating current for the trowel frame 3.

[0051] The concrete finishing device 1 does not require external electrical power supply. As a result, electrical power source cable setup work and handling work do not occur in the concrete finishing device 1 whereas electrical power source cable setup work and handling work occur in a device requiring external electrical power supply. Accordingly, the concrete finishing device 1 can be easily used with respect to the finishing work.

[0052] The sensor device 32 acquires various types of information for controlling the crawler frame 2 and the trowel frame 3. The sensor device 32 has an obstacle detection sensor 37, a surface sensor 38, and a camera 39.

[0053] The obstacle detection sensor 37 and the camera 39 obtain information for the crawler frame 2. The obstacle detection sensor 37 includes the contact sensor 37a and a non-contact sensor 37b. The bumpers 9 and 17 are provided with the contact sensor 37a. The non-contact sensor 37b is provided on, for example, a housing 5 of the electrical equipment frame 4. Specifically, a pair of the non-contact sensors 37b are provided on the left and right front sides of the housing 5. The non-contact sensor 37b emits a transmission wave such as an ultrasonic wave and laser light in the traveling direction of the concrete finishing device 1. In a case where an obstacle is present in the range

of the irradiation, the transmission wave is reflected by the obstacle. The non-contact sensor 37b detects the presence of the obstacle by receiving the reflected wave. With this configuration, it is possible to move the concrete finishing device 1 in accordance with the state of the work region. As a result, it is possible to suitably apply the concrete finishing device 1 even in a work region where an obstacle is present.

[0054] The camera 39 performs imaging in the traveling and backward directions of the concrete finishing device 1. The camera 39 is provided on the upper front side of the housing 5. The camera 39 acquires image information and the image information is provided for various types of control of the control device 33. For example, whether or not the finishing (leveling) state is sufficient may be determined by image processing based on the image information. The image information may be transmitted to the operation terminal 10 and displayed on the screen of the operation terminal 10. With this configuration, a worker operating the operation terminal 10 can confirm the state of the concrete surface S on the basis of the camera image. For example, the worker can determine whether or not the finishing (leveling) state of the concrete surface S is sufficient.

[0055] The surface sensor 38 and the camera 39 obtain information for the trowel frame 3. The surface sensor 38 obtains information related to the state of the concrete surface S in front of the trowel frame 3. Accordingly, the surface sensor 38 is provided in the front bottom portion of the housing 5. The information related to the state of the concrete surface S may include, for example, the presence or absence of unevenness on the concrete surface S, the degree of the unevenness, and

the degree of concrete curing. It can be said that the degree of the unevenness is surface smoothness. A surface hardness meter, a non-contact 3D scanner such as a laser scanner, or the like can be used as the surface sensor 38.

5 [0056] The smoothness is an index for quantitatively evaluating the roughness or surface roughness of the concrete surface S. In general, as for the smoothness, the difference between the irregularities of the concrete surface S, that is, the mountain-to-valley depth of the concrete surface S is measured in a certain region by means of a 3D scanner, a
10 laser sensor, or the like. The degree of the curing is an index indicating the degree of progress of concrete curing suitable for each stage of the finishing work. In general, the degree of the curing is evaluated as a supporting pressure (firmness). The degree of the curing is obtained by, for example, displacement-force relationship
15 measurement at a time when the concrete surface S is physically pressed or pierced, peripheral displacement measurement at a time of external force application to the concrete surface S, prediction from the moisture amount of the concrete surface S, or prediction using a change in temperature.

20 [0057] The control device 33 outputs a signal for controlling the crawler frame 2 and the trowel frame 3. The control device 33 generates a control signal on the basis of various types of information provided from the sensor device 32, a blade sensor 18a, and the motor sensor 13a. The control device 33 may output a signal for controlling
25 the operation of the water sprinkling device 14. The control device 33 has an input-output unit 33a, a movement trajectory calculation unit 33b,

a crawler control unit 33c, and a trowel control unit 33d. The control device 33 may be realized by, for example, a predetermined program being executed on a computer. In other words, a portable personal computer, a microcomputer, or the like may be used as the control device 33.

[0058] The electrical equipment frame 4 is provided with the control device 33 of the concrete finishing device 1. The control device 33 is not limited to this configuration. For example, the trowel frame 3 may be provided with the control device 33. The control device 33 may be realized by a program being executed on the operation terminal 10. The control device 33 may be realized by a computer that is different from the operation terminal 10 and is not mounted on the concrete finishing device 1.

[0059] The input-output unit 33a receives various types of information from the operation terminal 10, the sensor device 32, the blade sensor 18a, and the motor sensor 13a. For example, the input-output unit 33a receives information required for movement trajectory calculation from the operation terminal 10. Examples of this information include an overlapping range and the size (longitudinal and lateral lengths) of a finishing region. The overlapping range is a part of overlapping between the range that is finished by a movement along a first trajectory and the range that is finished by a movement along a second trajectory adjacent to the first trajectory. The input-output unit 33a receives the information that is related to the presence or absence of an obstacle and is provided from the obstacle detection sensor 37, the information that is related to the state of the concrete surface S (such as the degree of

unevenness) and is provided from the surface sensor 38, and the information that is related to the image of the concrete surface S and is provided from the camera 39.

[0060] The input-output unit 33a outputs the control signal generated by the control device 33 to the crawler frame 2 and/or the trowel frame 3. The input-output unit 33a may output information for work monitoring to the operation terminal 10. This information is displayed on, for example, the operation terminal 10. The information displayed on the operation terminal 10 is the information related to the state of the concrete surface S and provided from the surface sensor 38 and the image of the concrete surface S provided from the camera 39. The input-output unit 33a transmits the information related to the state of the concrete surface S, the image information on the concrete surface S, and the like to the operation terminal 10.

[0061] The movement trajectory calculation unit 33b calculates the movement trajectory of the concrete finishing device 1. The movement trajectory is a trajectory indicating a path through which the concrete finishing device 1 is scheduled to pass. The concrete finishing device 1 automatically calculates the movement trajectory on the basis of information input by the operation terminal 10. For example, the movement trajectory calculation unit 33b calculates the movement trajectory by using the overlapping range and the size (longitudinal and lateral lengths) of the finishing region.

[0062] The crawler control unit 33c provides a control signal for controlling the operation of the crawler frame 2. Specifically, the crawler control unit 33c provides a signal for controlling the rotation of

the motor 13 in the crawler frame 2. The crawler control unit 33c generates a control signal on the basis of information provided by the movement trajectory calculation unit 33b. First, the crawler control unit 33c controls the initiation of the rotation of the motor 13, the rotation speed of the motor 13, and stopping of the rotation of the motor 13 on the basis of the movement trajectory information provided from the movement trajectory calculation unit 33b such that the concrete finishing device 1 is moved along the movement trajectory. When an obstacle is present, the crawler control unit 33c moves the concrete finishing device 1 so as to avoid the obstacle. For example, the crawler control unit 33c detects the presence of the obstacle with information provided from the obstacle detection sensor 37 or the camera 39. Next, the crawler control unit 33c determines whether or not the movement of the concrete finishing device 1 is hindered by the obstacle. A movement trajectory for avoiding the obstacle is calculated in a case where it is determined that the movement of the concrete finishing device 1 is hindered. Then, the crawler control unit 33c controls the motor 13 of the crawler frame 2 such that the concrete finishing device 1 moves along the trajectory. The concrete finishing device 1 autonomously travels along the pre-programmed movement trajectory.

[0063] The concrete finishing device 1 travels along the movement trajectory as described above. However, a deviation between the position of the concrete finishing device 1 on the movement trajectory and the actual position of the concrete finishing device 1 may arise due to, for example, slipping between the belt 12 and the concrete surface S.

[0064] The crawler control unit 33c may perform interruption operation-based traveling control in addition to the preset path-based autonomous traveling control. The concrete finishing device 1 may be directly operated on the basis of information that a worker inputs from the operation terminal 10.

[0065] The crawler control unit 33c may perform control for correcting the movement trajectory by feeding back information related to the actual position of the concrete finishing device 1 in the work region. For example, a measurement device such as a geometer is disposed around the work region. The crawler control unit 33c transmits information provided from the measurement device to the concrete finishing device 1 by wireless communication. The geometer is the system name of a tracking total station. The geometer provides information on the position of an object in a continuous three-dimensional space. The concrete finishing device 1 may receive position information via the input-output unit 33a. Then, the crawler control unit 33c may adjust the control signal by using the position information. The configuration for obtaining information related to the actual position of the concrete finishing device 1 is not limited to the configuration using the total station. For example, a position measurement system using a laser range finder and a mirror may be used. The laser range finder is attached to the concrete finishing device 1. The mirror is disposed around the work region. The crawler control unit 33c may comprehensively control the traveling of the concrete finishing device 1 by combining external sensor information including a global navigation satellite system (GNSS),

traveling history information based on the rotary encoder provided in the motor 13, and position measurement information obtained by means of a geometer or the like.

[0066] The crawler control unit 33c may update the movement trajectory by using information provided from the sensor device 32. For example, the crawler control unit 33c obtains information related to an obstacle hindering the movement of the concrete finishing device 1 along the movement trajectory by using information provided from the contact sensor 37a, the non-contact sensor 37b, and the camera 39.

The crawler control unit 33c resets the movement trajectory so as to avoid the obstacle. It should be noted that the obstacle-related information may be generated by an element different from the crawler control unit 33c and given to the crawler control unit 33c.

[0067] The trowel control unit 33d provides a control signal for controlling the operation of the blade 19. For example, the trowel control unit 33d may control the rotation speed of the blade 19 such that the blade 19 reaches a preset and predetermined rotation speed. The rotation speed of the blade 19 is equivalent to the rotation speed of the motor 13. Accordingly, the rotation speed of the blade 19 can be controlled by the motor 13. The trowel control unit 33d may control the rotation speed of the blade 19 on the basis of information provided by a surface state evaluation unit 33e and/or a leveling situation acquisition unit 33f. The trowel control unit 33d may control the angle of the blade on the basis of information provided by the surface state evaluation unit 33e and/or the leveling situation acquisition unit 33f. The blade angle is the acute angle-side angle between the concrete

surface S and the blade 19.

[0068] The control device 33 further has the surface state evaluation unit 33e and the leveling situation acquisition unit 33f.

[0069] The surface state evaluation unit 33e may change the rotation speed of the blade 19 by using information provided from the surface sensor 38 and the camera 39. For example, in a case where the surface sensor 38 detects unevenness (undulation) on the concrete surface S, the surface state evaluation unit 33e controls the content of the finishing work by using information related to the unevenness. Examples of the unevenness-related information include the smoothness of the concrete surface S. The movement speed of the concrete finishing device 1 may be controlled by the smoothness being used. For example, the movement speed is relatively reduced in a case where the smoothness of the concrete surface S is rough (exceeds a threshold value). The rotation speed of the blade 19 in the trowel frame 3 may be controlled by the smoothness being used. It should be noted that the finishing operation may be performed again in a case where the smoothness of the concrete surface S does not reach a predetermined smoothness.

[0070] The surface state evaluation unit 33e may control the operation of the blade 19 of the concrete finishing device 1 by using the degree of the concrete curing in addition to the information related to the unevenness (undulation) on the concrete surface S. For example, the rotation speed of the blade 19 is increased as the degree of the concrete curing increases. In addition, the blade angle of the blade 19 is increased as the degree of the concrete curing increases. As a result of this control, efficient finishing can be performed in accordance with the

curing of the concrete surface S.

[0071] The surface state evaluation unit 33e controls at least one of the movement speed of the traveling unit and the rotation speed of the finishing mechanism in accordance with the smoothness of the concrete surface S and the degree of the concrete curing. A further satisfactory finished surface can be obtained as a result.

[0072] The surface state evaluation unit 33e may generate information related to the concrete surface S by using information provided from the surface sensor 38 and the camera 39. Further, the surface state evaluation unit 33e may provide the generated information for the crawler control unit 33c and the trowel control unit 33d. The crawler control unit 33c and the trowel control unit 33d use the information related to the concrete surface S in generating a control signal.

[0073] A blade measurement unit 33g provides information related to the rotation position, rotation speed, and blade angle of the blade 19 of the trowel frame 3. Specifically, the blade measurement unit 33g obtains the rotation position and rotation speed of the blade 19 by using the output of the blade sensor 18a such as the rotary encoders respectively provided on the shaft 18 of the trowel frame 3.

[0074] A blade trajectory acquisition unit 33h (finishing mechanism trajectory acquisition unit) calculates the movement trajectory of each blade 19. The movement trajectory of the blade 19 is a trajectory formed by the tip of the blade 19. The blade 19 rotates around rotation axes RA and RB. Further, the trowel frame 3 is pulled to the crawler frame 2. The tip of each blade 19 draws a spiral trajectory as a result of these two operations. The blade trajectory acquisition unit 33h

calculates the trajectory of each blade 19 by using the position and rotation speed of the blade 19 provided by the blade measurement unit 33g, the driving pulse of the motor 13 provided by the crawler frame 2, and the like.

[0075] The leveling situation acquisition unit 33f (surface leveling state acquisition unit) generates leveling situation information by using information provided by the blade measurement unit 33g and the blade trajectory acquisition unit 33h. Then, the leveling situation acquisition unit 33f provides the generated information for the crawler control unit 33c and the trowel control unit 33d. Information provided by the blade measurement unit 33g and the blade trajectory acquisition unit 33h constitutes the leveling situation information. The leveling situation information includes information related to the position, number of revolutions, and trajectory of the blade 19. The blade measurement unit 33g provides information on the rotation speed, rotation position, and blade angle of the blade 19. The blade trajectory acquisition unit 33h provides information related to the movement trajectory of the blade 19. The leveling situation acquisition unit 33f generates leveling situation-related information by using one or more of these pieces of information. Accordingly, the leveling situation information may be information including the numerical values of items such as the rotation speed and the rotation position.

[0076] For example, the leveling situation acquisition unit 33f detects an unfinished part that cannot be finished in the first trajectory by using information related to the position, number of revolutions, and trajectory of the blade 19. Then, in the second leveling work, the

traveling direction of the concrete finishing device 1 is set to a direction that is at 90° with respect to the traveling direction of the first leveling work. As a result of this movement direction control, a reliable finishing treatment can be performed on the unfinished part. It should be noted that a change in movement direction may be performed in the third or subsequent leveling work.

[0077] The concrete surface S is imaged by means of the camera 39. Then, information related to an iron pattern is obtained by the image obtained by the imaging being processed. Then, at least one of the movement speed of the concrete finishing device 1, the rotation speed of the blade 19, and the installation (blade) angle of the blade 19 may be selected and finishing control for non-appearance of the iron pattern may be performed such that the degree of the iron pattern does not exceed a threshold value.

[0078] The electrical equipment frame 4 has several components. The electrical equipment frame 4 has a pair of lamps 4a and an outrigger 4b. The electrical equipment frame 4 may include an emergency stop button, a rotary light, and the like as needed.

[0079] <Electrical Equipment Frame Coupling Unit>

The electrical equipment frame coupling unit 7 removably couples the electrical equipment frame 4 to the frame 8. The frame 8 of the crawler frame 2 and the electrical equipment frame 4 are provided with the electrical equipment frame coupling unit 7. The electrical equipment frame 4 is mounted substantially in the middle of the frame 8 in a longitudinal direction. The electrical equipment frame 4 is fixed to the frame 8 by the electrical equipment frame coupling unit 7. The

electrical equipment frame coupling unit 7 has four sets of pin hole units 25. Each pin hole unit 25 has a pin hole plate 25a, a pin hole plate 25b, and a pin 25c. The pin hole plate 25a is fixed to the frame 8. For example, two pin hole plates 25a and the other two pin hole plates 25a are respectively provided in the front and rear side portions of the frame 8 across a width-direction central axis. The pin hole plate 25b is fixed to the electrical equipment frame 4. The pin hole plates 25b are respectively fixed at positions corresponding to the pin hole plates 25a on the back surface of the electrical equipment frame 4.

[0080] The pin hole plates 25a and 25b are provided with through holes parallel to the horizontal direction H. The pins 25c are inserted into the through holes. In other words, the pins 25c are inserted into the pin hole plates 25a and 25b. The electrical equipment frame 4 is coupled to the frame 8 in this configuration. The pin 25c may be pulled out when the electrical equipment frame 4 is removed. Accordingly, the electrical equipment frame 4 can be easily attached to the crawler frame 2. Further, the electrical equipment frame 4 can be easily removed from the crawler frame 2.

[0081] The structure of the electrical equipment frame coupling unit 7 is not limited to the coupling structure using the pin 25c. Any mechanism capable of easily switching between fixed and released states may be adopted as the structure of the electrical equipment frame coupling unit 7.

[0082] The concrete finishing device 1 described above has the crawler frame 2, the trowel frame 3, and the electrical equipment frame 4. The trowel frame 3 is coupled to the frame 8 of the crawler frame 2 via the

trowel coupling unit 6. The electrical equipment frame 4 is coupled to the frame 8 of the crawler frame 2 via the electrical equipment frame coupling unit 7. The trowel coupling unit 6 removably couples the trowel frame 3 to the frame 8. Likewise, the electrical equipment frame coupling unit 7 removably couples the electrical equipment frame 4 to the frame 8. As a result, the concrete finishing device 1 can be disassembled into the crawler frame 2, the trowel frame 3, and the electrical equipment frame 4. Each unit is lighter in weight than the concrete finishing device 1 that is integrated. Accordingly, the concrete finishing device 1 can be easily transported.

[0083] The present invention is not limited to the above-described embodiment of the present invention and the present invention may be implemented in various forms.

[0084] <Flaking Unit>

A flaking unit 41 as an additional component may be attached to the trowel frame 3 as illustrated in FIG. 6. As described above, flaking means so-called rough leveling. "Flake" is cement paste resulting from cement dissolution in water. The fine particles contained in the concrete float as a result of the flaking work. As a result, a layer containing mortar as a main component is formed on the concrete surface S. In the related art, flaking work is performed by a worker using a wooden trowel.

[0085] The flaking unit 41 includes two flaking disks 42 and 43. The flaking disk 42 is attached to one blade unit 16A. The flaking disk 43 is attached to the other blade unit 16B. The only difference between the flaking disks 42 and 43 is the blade units 16A and 16B to which the

flaking disks 42 and 43 are attached and the flaking disks 42 and 43 have a common single-unit configuration. Hereinafter, the flaking disk 42 will be described in detail with the flaking disk 43 undescribed.

[0086] The flaking disk 42 has a disk portion 44 and an engagement portion 46. The disk portion 44 includes a bottom board 44a and a wall portion 44b. The wall portion 44b rises from the edge portion of the bottom board 44a. The diameter of the disk portion 44 is smaller than 50% of the distance from the rotation axis RA of the blade unit 16A to the rotation axis RB of the blade unit 16B. Accordingly, the diameter of the disk portion 44 is smaller than the diameter of the blade unit 16A. The diameter of the blade unit 16A is a diameter in a circular region leveled when the blade 19 rotates. A gap is generated between the flaking disks 42 and 43 when the two flaking disks 42 and 43 are attached to the blade units 16A and 16B.

[0087] The concrete contact surface of the bottom board 44a has a gently convex cross-sectional shape toward the concrete surface S in a cross-sectional view. Three engagement portions 46 are provided on the surface on the side that is opposite to the contact surface. The engagement portion 46 has an L shape in a cross-sectional view. The engagement portions 46 are fixed to the disk portion 44 at equal intervals (120-degree intervals) around the center line of the disk portion 44. The flaking disks 42 and 43 rotate with the rotation of the blade 19 by the blade 19 being engaged with this engagement portion 46. At this time, the concrete surface S is pressed by the weight of the trowel frame 3. In other words, during the work using the flaking unit 41, the concrete surface S is leveled while a predetermined pressure is

applied to the concrete surface S.

[0088] The flaking disk is not limited to a disk-shaped disk. For example, flaking boards 42A and 43A of a flaking unit 41A according to a modification example may have a substantially triangular planar shape (throwing knife type) as illustrated in FIG. 7. Further, the region between the flaking boards 42A and 43A is disposed such that the top portions of the flaking boards 42A and 43A pass alternately. In other words, the flaking boards 42A and 43A are disposed out of phase with respect to each other. In this configuration, either the flaking board 42A or the flaking board 43A always passes between the flaking boards 42A and 43A. No unfinished part is generated as a result.

[0089] A component different from the flaking disks 42 and 43 may be used as the flaking unit. For example, a cylindrical flaking tube (cylinder member) may be used. The flaking tube rotates around the rotation axis of the cylinder on the concrete surface S. As a result, the flaking tube rolls on the concrete surface S. A contact portion that is the circumferential surface of the flaking tube has the shape of a net having an air gap. In a case where the flaking tube is used, the trowel frame 3 may be removed from the crawler frame 2 and the flaking tube may be rotatably coupled. At this time, the coupling unit may have a function of adjusting the force of the flaking tube by which the concrete surface S is pressed.

[0090] A flaking component having a concrete contact surface on a spherical surface may be used as the flaking unit. The flaking component is attached to the shaft 18 of the blade units 16A and 16B via attachment similarly to the flaking tube. Not rotation but reciprocating

vibration in a direction parallel to the concrete surface S is performed in the case of the flaking component. This reciprocating vibration may be generated by attachment.

[0091] In the concrete finishing device 1 according to the embodiment described above, the trowel frame 3 (finishing unit) is coupled to the crawler frame 2 (traveling unit). For example, the trowel frame 3 may be coupled to the electrical equipment frame 4 (electrical power source unit) instead of the crawler frame 2. In other words, the trowel coupling unit may couple the trowel frame 3 to the electrical equipment frame 4.

[0092] As for the flaking unit, the blade 19 (first blade) of the trowel frame 3 may be replaced with a flaking blade (second blade) for flaking. The flaking blade is higher in rigidity than the blade 19 used for the unevenness adjustment work. In addition, the concrete contact surface of the flaking blade has a cross section having the shape of a gently convex surface. The blade 19 or the flaking blade is selectively mounted onto the blade units 16A and 16B in accordance with the content of the finishing work. In other words, the blade 19 is mounted during the unevenness adjustment work. Further, the flaking blade is mounted during the flaking work.

Reference Signs List

[0093] 1: concrete finishing device, 2: crawler frame (traveling unit), 3: trowel frame (finishing unit), 4: electrical equipment frame (electrical power source unit), 4a: lamp, 4b: outrigger, 5: housing, 6: trowel coupling unit (first coupling unit), 7: electrical equipment frame coupling unit (second coupling unit), 8: frame, 9: bumper, 10: operation

terminal, 11: crawler unit (endless track), 12: belt, 13: motor (first motor), 13a: motor sensor (traveling sensor), 12a: edge, 14: water sprinkling device, 15: blade motor (second motor), 16A, 16B: blade unit (finishing mechanism), 17: bumper, 18: shaft, 18a: blade sensor, 19: blade, 20: guide, 21, 22: coupling plate, 22a: guide hole, 23A, 23B, 23C, 23D: spring unit, 23a: wire spring (elastic member), 23b: base, 24: snap lock, 24a: lever, 24b: projection, 25: pin hole unit, 25a, 25b: pin hole plate, 25c: pin, 26: coupling unit, 26a: guide hole, 28: pin, 31: electrical power source device, 32: sensor device, 33: control device, 33a: input-output unit, 33b: movement trajectory calculation unit, 33c: crawler control unit, 33d: trowel control unit, 33e: surface state evaluation unit, 33f: leveling situation acquisition unit, 33g: blade measurement unit, 33h: blade trajectory acquisition unit (finishing mechanism trajectory acquisition unit), 34: battery, 36: electrical power conversion circuit, 37: obstacle detection sensor, 37a: contact sensor, 37b: non-contact sensor, 38: surface sensor, 39: camera, 41: flaking unit, 42, 43: flaking disk, 44: disk portion, 44a: bottom board, 44b: wall portion, 46: engagement portion, V: vertical direction, H: horizontal direction, S: concrete surface.

CLAIMS

1. A concrete finishing device comprising:
 - a traveling unit having an endless track provided on a frame;
 - an electrical power source unit mounted to the frame and supplying
 - 5 electrical power to the traveling unit;
 - a finishing unit coupled to the frame of the traveling unit or the electrical power source unit and finishing a concrete surface with a finishing mechanism rotating while in contact with the concrete surface;
 - a first coupling unit removably coupling the finishing unit to the
 - 10 frame of the traveling unit or the electrical power source unit; and
 - a second coupling unit removably coupling the electrical power source unit to the frame of the traveling unit,
 - the traveling unit is disposed so as to drag the finishing unit, and
 - the first coupling unit has an elastic member having flexibility
 - 15 along a vertical direction and is deformed in the vertical direction by a weight of the finishing unit so as to allow a relative movement of the finishing unit in the vertical direction with respect to the frame of the traveling unit or the electrical power source unit.
2. The concrete finishing device according to claim 1, wherein the
- 20 first coupling unit removably couples the finishing unit to the frame of the traveling unit.
3. The concrete finishing device according to claim 1 or 2, further comprising:
 - a sensor unit obtaining information related to a state of the concrete
 - 25 surface; and
 - a control unit generating a control signal for at least one of the

traveling unit and the finishing unit by using the information obtained by the sensor unit.

4. The concrete finishing device according to claim 3, wherein the finishing mechanism has a blade rotating while in contact with the concrete surface, a rotary shaft to which the blade is coupled, and a blade motor driving the rotary shaft, and the blade is configured to be removable from the rotary shaft.

5. The concrete finishing device according to claim 4, wherein the control unit controls at least one of a movement speed of the traveling unit, a rotation speed of the blade, and a blade angle of the blade with respect to the concrete surface.

6. The concrete finishing device according to claim 4 or 5, wherein the control unit has a leveling situation acquisition unit obtaining information related to a leveling situation of the concrete surface by using at least one of a movement speed of the traveling unit, a movement trajectory of the blade, a rotation speed of the blade, and a blade angle of the blade with respect to the concrete surface, and

the control unit generates the control signal by using the information obtained by the leveling situation acquisition unit.

7. The concrete finishing device according to any one of claims 4 to 6, wherein

the sensor unit has a surface sensor acquiring at least one of information related to smoothness of the concrete surface and information related to a degree of curing of the concrete surface as information related to the state of the concrete surface, and

the control unit generates the control signal by using the

information obtained by the surface sensor.

8. The concrete finishing device according to any one of claims 4 to 7, wherein

the sensor unit further has an obstacle detection sensor detecting an obstacle present such that a movement by the traveling unit is hindered on the concrete surface, and

the obstacle detection sensor includes:

a contact sensor detecting the obstacle by contact with the obstacle;

and

a non-contact sensor detecting the obstacle without contact by emitting a transmission wave to the obstacle and using a reflected wave from the obstacle.

9. The concrete finishing device according to any one of claims 1 to 3, wherein the finishing mechanism is a cylinder member in which a contact portion coming into contact with the concrete surface has an air gap and levels the concrete surface by rotating around a rotation axis of the cylinder member as the traveling unit travels.

10. The concrete finishing device according to any one of claims 1 to 3, wherein

the finishing mechanism includes:

a first blade in which a contact portion coming into contact with the concrete surface is flexible; and

a second blade in which a contact portion coming into contact with the concrete surface is higher in rigidity than the first blade and the contact portion has a convex surface-shaped surface, and

the first blade and the second blade are selectively mounted onto

the finishing mechanism in accordance with content of finishing work.

11. The concrete finishing device according to any one of claims 1 to 10, wherein

the traveling unit is electrically connected to the electrical power source unit and the endless track is driven by a first motor performing driving by using electrical power supplied from the electrical power source unit, and

the finishing unit is electrically connected to the electrical power source unit and the finishing mechanism is driven by a second motor performing driving by using electrical power supplied from the electrical power source unit.

12. The concrete finishing device according to any one of claims 1 to 11, wherein

the traveling unit has a concrete adhesion suppression unit suppressing adhesion of the concrete to a contact surface of the endless track coming into contact with the concrete surface, and

the concrete adhesion suppression unit supplies an adhesion suppression substance to the contact surface.