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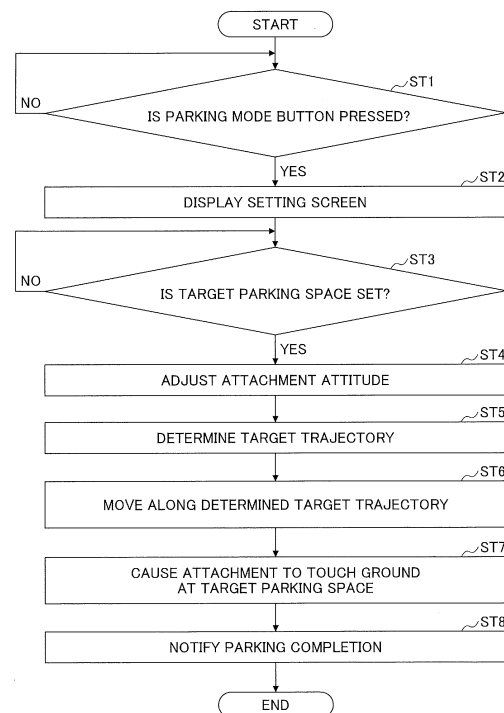
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(54) **SHOVEL**

(57) A shovel (100) according to an embodiment of the present invention includes a lower-part traveling body (1), an upper-part swing body (3) that is turnably mounted on the lower-part traveling body (1), a hydraulic traveling motor (2M) as a traveling actuator that drives the lower-part traveling body (1), a space recognition device (70) that is provided in the upper-part swinging body (3), an orientation detection device (71) that detects information related to a relative relation between an orientation of the upper-part swing body (3) and an orientation of the lower-part traveling body (1), and a controller (30) as a control device that is provided in the upper-part swing body (3).

FIG.7



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Description

TECHNICAL FIELD

[0001] The present invention relates to a shovel.

BACKGROUND ART

[0002] Conventionally, a shovel is known which automatically extends and contracts a boom cylinder, an arm cylinder, and a bucket cylinder, in accordance with a button operation of an operator, in order to cause a posture of an attachment to be suitable for parking (refer to Patent Document 1).

PRIOR ART DOCUMENTS

[Patent Document]

[0003] [Patent Document 1] Japanese Unexamined Patent Application Publication No. H8-136737

SUMMARY OF THE INVENTION

[TECHNICAL PROBLEM]

[0004] However, the above-described shovel is only capable of automatically changing a posture of an attachment, and is unable to automatically move the shovel to a parking location.

[0005] Therefore, it is desirable to provide a shovel that can assist in moving to a parking location.

[SOLUTION TO PROBLEM]

[0006] According to an embodiment of the present invention, a shovel is provided. The shovel includes a lower-part traveling body, an upper-part swing body that is turnably mounted on the lower-part traveling body, a traveling actuator that drives the lower-part traveling body, a space recognition device that is provided in the upper-part swinging body, an orientation detection device that detects information related to a relative relation between an orientation of the upper-part swing body and an orientation of the lower-part traveling body, and a control device that is provided in the upper swinging body, wherein the control device causes the traveling actuator to operate, based on an output of the space recognition device and an output of the orientation detection device.

[ADVANTAGEOUS EFFECTS OF INVENTION]

[0007] According to the above solution, a shovel is provided which can assist in moving to a parking location.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008]

Fig. 1 is a side view of a shovel according to an embodiment of the present invention.

Fig. 2 is a top view of the shovel of Fig. 1.

Fig. 3 is a diagram illustrating a configuration example of a hydraulic system installed in the shovel of Fig. 1.

Fig. 4A is a diagram illustrating a part of the hydraulic system related to an operation of an arm cylinder.

Fig. 4B is a diagram illustrating a part of the hydraulic system related to an operation of a hydraulic swing motor.

Fig. 4C is a diagram illustrating a part of the hydraulic system related to an operation of a boom cylinder.

Fig. 4D is a drawing illustrating a part of the hydraulic system related to an operation of a bucket cylinder.

Fig. 5A is a diagram illustrating a part of the hydraulic system related to an operation of a left hydraulic traveling motor.

Fig. 5B is a diagram illustrating a part of the hydraulic system related to an operation of a right hydraulic traveling motor.

Fig. 6 is a functional block diagram illustrating a configuration example of a controller.

Fig. 7 is a flowchart illustrating an example of a parking process.

Fig. 8 is a drawing illustrating an example of a parking space selection screen.

Fig. 9 is a top view of an example of an actual parking lot.

Fig. 10 is a drawing illustrating another example of a parking space selection screen.

Fig. 11 is a top view of another example of an actual parking lot.

Fig. 12 is a drawing illustrating a yet another example of a parking space selection screen.

Fig. 13 is a drawing illustrating a yet another example of a parking space selection screen.

Fig. 14 is a functional block diagram illustrating a configuration example of another controller.

Fig. 15 is a diagram illustrating a configuration example of an electronically-controlled operation system.

Fig. 16 is a schematic diagram illustrating a configuration example of a shovel management system.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0009] First, referring to Fig. 1 and Fig. 2, a shovel 100 as an excavator according to an embodiment of the present invention will be described. Fig. 1 is a side view of the shovel 100, and Fig. 2 is a top view of the shovel 100.

[0010] According to an embodiment of the present invention, a lower-part traveling body 1 of the shovel 100 includes a crawler 1C. The crawler 1C is driven by a hydraulic traveling motor 2M as a traveling actuator installed in the lower-part traveling body 1. Specifically, the

crawler 1C includes a left crawler 1CL and a right crawler 1CR. The left crawler 1CL is driven by a left hydraulic traveling motor 2ML, and the right crawler 1CR is driven by a right hydraulic traveling motor 2MR.

[0011] An upper-part swing body 3 is turnably mounted on the lower-part traveling body 1 via a swing mechanism 2. The swing mechanism 2 is driven by a hydraulic swing motor 2A as a swing actuator installed in the upper-part swing body 3. It should be noted, however, the swing actuator may be a swing motor generator as an electronic actuator.

[0012] A boom 4 is attached to the upper-part swing body 3. An arm 5 is attached to a top end of the boom 4, and a bucket 6 as an end attachment is attached to a top end of the arm 5. The boom 4, the arm 5, and the bucket 6 form an excavating attachment AT as an example of an attachment. The boom 4 is driven by a boom cylinder 7, the arm 5 is driven by an arm cylinder 8, and the bucket 6 is driven by a bucket cylinder 9. The boom cylinder 7, the arm cylinder 8, and the bucket cylinder 9 form an attachment actuator.

[0013] The boom 4 is rotatably supported to rotate up and down with respect to the upper-part swing body 3. Further, a boom angle sensor S1 is attached to the boom 4. The boom angle sensor S1 is capable of detecting a boom angle $\theta 1$ as a rotational angle of the boom 4. The boom angle $\theta 1$ is, for example, an increased angle from a state in which the boom 4 is lowered most. Therefore, the boom angle $\theta 1$ becomes a maximum when the boom 4 is lifted most.

[0014] The arm 5 is rotatably supported to rotate with respect to the boom 4. Further, an arm angle sensor S2 is attached to the arm 5. The arm angle sensor S2 is capable of detecting an arm angle $\theta 2$ as a rotational angle of the arm 5. The arm angle $\theta 2$ is, for example, a opened angle from a state in which the arm 5 is closed most. Therefore, the arm angle $\theta 2$ becomes a maximum when the arm 5 is opened most.

[0015] The bucket 6 is rotatably supported to rotate with respect to the arm 5. Further, a bucket angle sensor S3 is attached to the bucket 6. The bucket angle sensor S3 is capable of detecting a bucket angle $\theta 3$ as a rotational angle of the bucket 6. The bucket angle $\theta 3$ is an opened angle from a state in which the bucket 6 is closed most. Therefore, the bucket angle $\theta 3$ becomes a maximum when the bucket 6 is opened most.

[0016] In an embodiment of the present invention in Fig. 1, each of the boom angle sensor S1, the arm angle sensor S2, and the bucket angle sensor S3 is formed by a combination of an acceleration sensor and a gyro sensor. It should be noted, however, that at least one of the boom angle sensor S1, the arm angle sensor S2, and the bucket angle sensor S3 may be formed by an acceleration sensor alone. Furthermore, the boom angle sensor S1 may be a stroke sensor attached to the boom cylinder 7, or may be a rotary encoder, a potentiometer, an inertia measurement device, or the like. The arm angle sensor S2 and the bucket angle sensor S3 are the same

as the boom angle sensor S1.

[0017] A cabin 10 as an operator's cab is provided in the upper-part swing body 3 and a power source such as an engine 11 is installed in the upper-part swing body 3. Further, a space recognition device 70, an orientation detection device 71, a positioning device 73, a device body inclination sensor S4, a swing angular velocity sensor S5, etc., are attached to the upper-part swing body 3. An operation device 26, a controller 30, an information input device 72, a display device D1, a sound output device D2, etc., are provided in the cabin 10. It should be noted that, in this specification, for the sake of convenience, a side on which the excavating attachment AT is attached to in the upper-part swing body 3 is referred to as a front side, and a side on which a counter weight is attached to is referred to as a rear side.

[0018] The space recognition device 70 is configured to recognize an object existing in a three-dimensional space surrounding the shovel 100. Further, the space recognition device 70 is configured to calculate a distance from the space recognition device 70 or the shovel 100 to the recognized object. The space recognition device 70 is, for example, an ultrasonic sensor, a millimeter wave radar, a monocular camera, a stereo camera, a LIDAR, a distance image sensor, an infrared sensor, or the like. In an embodiment of the present invention, the space recognition device 70 includes: a front side sensor 70F attached to a front end of an upper surface of the cabin 10; a rear side sensor 70B attached to a rear end of the upper surface of the upper-part swing body 3; a left side sensor 70L attached to a left end of the upper surface of the upper-part swing body 3; and a right side sensor 70R attached to a right end of the upper surface of the upper-part swing body 3. An upper side sensor that recognizes an object existing in an upper space of the upper-part swing body 3 may be attached to the shovel 100.

[0019] The space recognition device 70 may be configured to detect an object existing around the shovel 100. The object is, for example, a person, an animal, a vehicle (such as a dump truck), work equipment, a construction machine, a building, a wire, a fence, a hole, or the like. In a case where the space recognition device 70 is configured to detect a person as an object, the space recognition device 70 is configured to distinguish between a person and an object that is not a person. Further, The space recognition device 70 may be configured to identify a type of an object.

[0020] The space recognition device 70 may be configured to recognize a condition of a road surface. Specifically, the space recognition device 70 may be configured to, for example, identify a type of an object existing on the road surface. The type of the object existing on the road surface is, for example, a tobacco, a can, a pet bottle, a stone, or the like.

[0021] The orientation detection device 71 is configured to detect information related to a relative relationship between an orientation of the upper-part swing body 3

and an orientation of the lower-part traveling body 1. The orientation detection device 71 may be formed by, for example, a combination of geomagnetic sensor attached to the lower-part traveling body 1 and a geomagnetic sensor attached to the upper-part swing body 3. Alternatively, the orientation detection device 71 may be formed by a combination of a GNSS receiver attached to the lower-part traveling body 1 and a GNSS receiver attached to the upper-part swing body 3. The orientation detection device 71 may be a rotary encoder, a rotary position sensor, or the like. In a case where the upper-part swing body 3 is driven to swing by a swing motor generator, the orientation detection device 71 may be formed by a resolver. The orientation detection device 71 may be attached to, for example, a center joint that is provided in relation to the swing mechanism 2 that realizes a relative rotation between the lower-part traveling body 1 and the upper-part swing body 3.

[0022] The orientation detection device 71 may be formed by a camera attached to the upper-part swing body 3. In this case, the orientation detection device 71 applies a known image processing to an image (input image) captured by the camera attached to the upper-part swing body 3 and detects an image of the lower-part traveling body 1 included in the input image. Further, the orientation detection device 71 identifies a longitudinal direction of the lower-part traveling body 1 by detecting the image of the lower-part traveling body 1 using a known image recognition technology. Further, the orientation detection device 71 derives an angle formed between a front-rear axis direction of the upper-part swing body 3 and the longitudinal direction of the lower-part traveling body 1. The front-rear axis direction of the upper-part swing body 3 is derived from a position to which the camera is attached. Because the crawler 1C protrudes from the upper-part swing body 3, the orientation detection device 71 can determine the longitudinal direction of the lower-part traveling body 1 by detecting an image of the crawler 1C. In this case, the orientation detection device 71 may be integrated with the controller 30.

[0023] The information input device 72 is configured in such a way that an operator of the shovel can input information to the controller 30. In an embodiment of the present invention, the information input device 72 is a switch panel provided close to a display unit of the display device D1. It should be noted, however, that the information input device 72 may be a touch panel provided on the display unit of the display device D1, or may be a sound input device such as a microphone provided in the cabin 10.

[0024] The positioning device 73 is configured to measure a location of the upper-part swing body 3. In an embodiment of the present invention, the positioning device 73 is a GNSS receiver, detects a location of the upper-part swing body 3, and outputs a detected value to the controller 30. The positioning device 73 may be a GNSS compass. In this case, the positioning device 73 can detect a location and an orientation of the upper-part

swing body 3.

[0025] The device body inclination sensor S4 is configured to detect an inclination of the upper-part swing body 3 with respect to a predetermined plane. In an embodiment of the present invention, the device body inclination sensor S4 is an acceleration sensor that detects: an inclination angel (roll angle) around the front-rear axis of the upper-part swing body 3 with respect to a horizontal plane; and an inclination angle (pitch angle) around the left-right axis. The front-rear axis and the left-right axis of the upper-part swing body 3 are, for example, perpendicular to each other, and pass through a shovel center point that is a point on a swing axis of the shovel 100. The device body inclination sensor S4 may be a combination of an acceleration sensor and a gyro sensor.

[0026] The swing angular velocity sensor S5 detects a swing angular velocity of the upper-part swing body 3. In an embodiment of the present invention, the swing angular velocity sensor S5 is a gyro sensor. The swing angular velocity sensor S5 may be a resolver, a rotary encoder, or the like. The swing angular velocity sensor S5 may detect a swing velocity. The swing velocity may be calculated from the swing angular velocity.

[0027] Hereinafter, at least one of the boom angle sensor S1, the arm angle sensor S2, the bucket angle sensor S3, the device body inclination sensor S4, and the swing angular velocity sensor S5 is referred to as a posture detection device. The posture of the excavating attachment AT is detected based on, for example, respective outputs of the boom angle sensor S1, the arm angle sensor S2, the bucket angle sensor S3,

[0028] The display device D1 is configured to display various information items. In an embodiment of the present invention, the display device D1 is a liquid crystal display provided in the cabin 10. It should be noted, however, that the display device D1 may be a display of a mobile terminal such as a smart phone.

[0029] The sound output device D2 is configured to output sound. The sound output device D2 includes at least one of: a device that outputs sound to an operator in the cabin 10; and a device that outputs sound to workers outside the cabin 10. The sound output device D2 may be a speaker of a mobile terminal.

[0030] The operation device 26 is a device used by an operator for operating an actuator. The operation device 26 includes, for example, an operation lever and an operation pedal. The actuator includes at least one of a hydraulic actuator and an electronic actuator.

[0031] The controller 30 is a control device for controlling the shovel 100. In an embodiment of the present invention, the controller 30 is formed by a computer including a CPU, a RAM, a NVRAM, a ROM, etc. Further, the controller 30 reads programs corresponding to respective functions from the ROM, loads the programs to the RAM, and causes the CPU to execute corresponding processes. The respective functions include, for example: a machine guidance function for guiding manual operations of the shovel 100 by an operator; and a machine

control function for assisting the manual operations of the shovel 100 by an operator, or for causing the shovel 100 to operate automatically or autonomously.

[0032] Next, referring to Fig. 3, a configuration example of a hydraulic system installed in the shovel 100 will be described. Fig. 3 is a diagram illustrating a configuration example of a hydraulic system installed in the shovel 100. In Fig. 3, a mechanical power transmission system, hydraulic oil lines, pilot lines, and an electrical control system are indicated by double lines, solid lines, dashed lines, and dotted lines, respectively.

[0033] The hydraulic system of the shovel 100 mainly includes an engine 11, a regulator 13, a main pump 14, a pilot pump 15, a control valve 17, the operation device 26, a discharge pressure sensor 28, an operation pressure sensor 29, the controller 30, etc.

[0034] In FIG. 3, the hydraulic system is configured to circulate the hydraulic oil from a main pump 14 driven by the engine 11 to the hydraulic oil tank via a center bypass line 40 or a parallel line 42.

[0035] The engine 11 is a drive source of the shovel 100. In an embodiment of the present invention, the engine 11 is a diesel engine that operates to maintain a predetermined speed. An output shaft of the engine 11 is coupled to respective input shafts of the main pump 14 and the pilot pump 15.

[0036] The main pump 14 is configured to supply the hydraulic oil to the control valve 17 via the hydraulic oil line. In an embodiment of the present invention, the main pump 14 is a swash plate variable displacement hydraulic pump.

[0037] The regulator 13 is configured to control discharge amount of the main pump 14. In an embodiment of the present invention, the regulator 13 controls the discharge amount (displacement volume) of the main pump 14 by adjusting a swash plate tilting angle of the main pump 14 in response to a control command from the controller 30.

[0038] The pilot pump 15 is configured to supply the hydraulic oil to hydraulic control devices including the operation device 26 via the pilot line. In an embodiment of the present invention, the pilot pump 15 is a fixed capacitive hydraulic pump. It should be noted, however, that the pilot pump 15 may be omitted. In this case, the function performed by the pilot pump 15 may be performed by the main pump 14. In other words, the main pump 14 may have a function of, in addition to the function of supplying hydraulic oil to the control valve 17, supplying hydraulic oil to the operation device 26, etc., after reducing the hydraulic oil pressure by an aperture, or the like.

[0039] The control valve 17 is a hydraulic control device that control the hydraulic system in the shovel 100. In an embodiment of the present invention, the control valve 17 includes control valves 171 to 176. The control valve 175 includes a control valve 175L and a control valve 175R, and the control valve 176 includes a control valve 176L and a control valve 176R. The control valve

17 is configured to selectively supply hydraulic oil that is discharged by the main pump 14 to one or more hydraulic actuators through control valves 171 to 176. The control valves 171 to 176 control, for example: a flow rate of hydraulic oil that flows from the main pump 14 to the hydraulic actuators; and a flow rate of hydraulic oil that flows from the hydraulic actuators to a hydraulic oil tank. The hydraulic actuators include the boom cylinder 7, the arm cylinder 8, the bucket cylinder 9, the left hydraulic traveling motor 2ML, the right hydraulic traveling motor 2MR, and the hydraulic swing motor 2A.

[0040] The operation device 26 is configured to supply the hydraulic oil that is discharged by the pilot pump 15 to a pilot port of a corresponding control valve in the control valve 17 via the pilot line. A pressure (pilot pressure) of the hydraulic oil, which is supplied to each of the pilot ports, is a pressure in accordance with an operation direction and an operation amount of the operation device 26 corresponding to each of the hydraulic actuators. It should be noted, however, that the operation device 26 may not be of a pilot pressure type as described above, but may be of an electric control type. In this case, the control valve in the control valve 17 may be an electromagnetic solenoid spool valve.

[0041] The discharge pressure sensor 28 is configured to detect a discharge pressure of the main pump 14. In an embodiment of the present invention, the discharge pressure sensor 28 outputs a detected value to the controller 30.

[0042] The operation pressure sensor 29 is configured to detect an operated content of the operation device 26 by an operator. In an embodiment of the present invention, the operation pressure sensor 29 detects, in the form of a pressure (operation pressure), an operation direction and an operation amount of the operation device 26 corresponding to each of the actuators, and outputs detected values to the controller 30. The operated content of the operation device 26 may be detected by using a sensor other than the operation pressure sensor.

[0043] The main pump 14 includes a left main pump 14L and a right main pump 14R. Further, the left main pump 14L circulates the hydraulic oil to the hydraulic oil tank via a left center bypass line 40L or a left parallel line 42L. The right main pump 14R circulates the hydraulic oil to the hydraulic oil tank via a right center bypass line 40R or a right parallel line 42R.

[0044] The left center bypass line 40L is a hydraulic oil line that passes control valves 171, 173, 175L and 176L provided in the control valve 17. The right center bypass line 40R is a hydraulic oil line that passes control valves 172, 174, 175R and 176R provided in the control valve 17.

[0045] The control valve 171 is a spool valve that switches the flow of the hydraulic oil in order to: supply hydraulic oil, which is discharged from the left main pump 14L, to the left hydraulic traveling motor 2ML; and discharge hydraulic oil, which is discharged from the left hydraulic traveling motor 2ML, to the hydraulic oil tank.

[0046] The control valve 172 is a spool valve that switches the flow of the hydraulic oil in order to: supply hydraulic oil, which is discharged from the right main pump 14R, to the right hydraulic traveling motor 2MR; and discharge hydraulic oil, which is discharged from the right hydraulic traveling motor 2MR, to the hydraulic oil tank.

[0047] The control valve 173 is a spool valve that switches the flow of the hydraulic oil in order to: supply hydraulic oil, which is discharged from the left main pump 14L, to the hydraulic swing motor 2A; and discharge hydraulic oil, which is discharged from the hydraulic swing motor 2A, to the hydraulic oil tank.

[0048] The control valve 174 is a spool valve that switches the flow of the hydraulic oil in order to: supply hydraulic oil, which is discharged from the right main pump 14R, to the bucket cylinder 9; and discharge hydraulic oil in the bucket cylinder 9 to the hydraulic oil tank.

[0049] The control valve 175L is a spool valve that switches the flow of the hydraulic oil in order to supply hydraulic oil, which is discharged from the left main pump 14L, to the boom cylinder 7. The control valve 175R is a spool valve that switches the flow of the hydraulic oil in order to: supply hydraulic oil, which is discharged from the right main pump 14R, to the boom cylinder 7; and discharge hydraulic oil in the boom cylinder 7 to the hydraulic oil tank.

[0050] The control valve 176L is a spool valve that switches the flow of the hydraulic oil in order to: supply hydraulic oil, which is discharged from the left main pump 14L, to the arm cylinder 8; and discharge hydraulic oil in the arm cylinder 8 to the hydraulic oil tank.

[0051] The control valve 176R is a spool valve that switches the flow of the hydraulic oil in order to: supply hydraulic oil, which is discharged from the right main pump 14R, to the arm cylinder 8; and discharge hydraulic oil in the arm cylinder 8 to the hydraulic oil tank.

[0052] The left parallel line 42L is a hydraulic oil line parallel to the left center bypass line 40L. In the case where the flow of hydraulic oil, which flows in the left center bypass line 40L, is limited or cut off by any of the control valves 171, 173, and 175L, the left parallel line 42L is capable of supplying hydraulic oil to a control valve located downstream from the any of the control valves 171, 173, and 175L. The right parallel line 42R is a hydraulic oil line parallel to the right center bypass line 40R. In the case where the flow of hydraulic oil, which flows in the right center bypass line 40R, is limited or cut off by any of the control valves 172, 174, and 175R, the right parallel line 42R is capable of supplying hydraulic oil to a control valve located downstream from the any of the control valves 172, 174, and 175R.

[0053] The regulator 13 includes a left regulator 13L and a right regulator 13R. The left regulator 13L controls the discharge amount of the left main pump 14L by adjusting a swash plate tilting angle of the left main pump 14L in response to a discharge pressure of the left main pump 14L. Specifically, the left regulator 13L reduces the

discharge amount by adjusting the swash plate tilting angle of the left main pump 14L in response the increase of the discharge pressure of the left main pump 14L. The same applies to the right regulator 13R. The above arrangement is for preventing the absorption power (e.g., absorption horsepower) of the main pump 14, which is expressed as the product of the discharge pressure and the discharge amount, from exceeding the output power (e.g., output horsepower) of the engine 11.

[0054] The operation device 26 includes a left operation lever 26L, a right operation lever 26R, and a traveling lever 26D. The traveling lever 26D includes a left traveling lever 26DL and a right traveling lever 26DR.

[0055] Left operation lever 26L is used for a swing operation and an operation of the arm 5. When the left operation lever 26L is operated in a front-rear direction, a control pressure in accordance with the operation amount of the lever is introduced to a pilot port of the control valve 176 by using the hydraulic oil discharged from the pilot pump 15. Further, when the left operation lever 26L is operated in a left-right direction, a control pressure in accordance with the operation amount of the lever is introduced to a pilot port of the control valve 173 by using the hydraulic oil discharged from the pilot pump 15.

[0056] Specifically, in the case where the left operation lever 26L is operated in an arm closing direction, the hydraulic oil is introduced to a right-side pilot port of the control valve 176L and the hydraulic oil is introduced to a left-side pilot port of the control valve 176R. Specifically, in the case where the left operation lever 26L is operated in an arm closing direction, the hydraulic oil is introduced to a left-side pilot port of the control valve 176L and the hydraulic oil is introduced to a left-side pilot port of the control valve 176R. Further, in the case where the left operation lever 26L is operated in a left swing direction, the hydraulic oil is introduced to a left-side pilot port of the control valve 173 and, in the case where the left operation lever 26L is operated in a right swing direction, the hydraulic oil is introduced to a right-side pilot port of the control valve 173.

[0057] the right operation lever 26R is used for an operation of the boom 4 and an operation of the bucket 6. When the right operation lever 26R is operated in a front-rear direction, a control pressure in accordance with the operation amount of the lever is introduced to a pilot port of the control valve 175 by using the hydraulic oil discharged from the pilot pump 15. Further, when the right operation lever 26R is operated in a left-right direction, a control pressure in accordance with the operation amount of the lever is introduced to a pilot port of the control valve 174 by using the hydraulic oil discharged from the pilot pump 15.

[0058] Specifically, in the case where the right operation lever 26R is operated in a boom down direction, the hydraulic oil is introduced to a right-side pilot port of the control valve 175R. Further, in the case where the right operation lever 26R is operated in a boom up direction,

the hydraulic oil is introduced to a right-side pilot port of the control valve 175L and the hydraulic oil is introduced to a left-side pilot port of the control valve 175R. Further, in the case where the right operation lever 26R is operated in a bucket close direction, the hydraulic oil is introduced to a left-side pilot port of the control valve 174 and, in the case where the right operation lever 26R is operated in a bucket open direction, the hydraulic oil is introduced to a right-side pilot port of the control valve 174.

[0059] The traveling lever 26D is used for an operation of the crawler 1C. Specifically, the left traveling lever 26DL is used for an operation of the left crawler 1CL. The left traveling lever 26DL may be configured to move together with a left traveling pedal. When the left traveling lever 26DL is operated in a front-rear direction, a control pressure in accordance with the operation amount of the lever is introduced to a pilot port of the control valve 171 by using the hydraulic oil discharged from the pilot pump 15. The right traveling lever 26DR is used for an operation of the right crawler 1CR. The right traveling lever 26DR may be configured to move together with a right traveling pedal. When the right traveling lever 26DR is operated in a front-rear direction, a control pressure in accordance with the operation amount of the lever is introduced to a pilot port of the control valve 172 by using the hydraulic oil discharged from the pilot pump 15.

[0060] The discharge pressure sensor 28 includes a discharge pressure sensor 28L and a discharge pressure sensor 28R. The discharge pressure sensor 28L detects a discharge pressure of the left main pump 14L, and outputs the detected value to the controller 30. The same is applied to the discharge pressure sensor 28R.

[0061] The operation pressure sensor 29 includes an operation pressure sensors 29LA, 29LB, 29RA, 29RB, 29DL, and 29DR. The operation pressure sensor 29LA detects, in the form of a pressure, operation contents of the left operation lever 26L in a front-rear direction by an operator, and outputs the detected values to the controller 30. The operation contents are, for example, a lever operation direction and a lever operation amount (lever operation angle), or the like.

[0062] Similarly, the operation pressure sensor 29LB detects, in the form of a pressure, operation contents of the left operation lever 26L in a left-right direction by an operator, and outputs the detected values to the controller 30. The operation pressure sensor 29RA detects, in the form of a pressure, operation contents of the right operation lever 26R in a front-rear direction by an operator, and outputs the detected values to the controller 30. The operation pressure sensor 29RB detects, in the form of a pressure, operation contents of the right operation lever 26R in a left-right direction by an operator, and outputs the detected values to the controller 30. The operation pressure sensor 29DL detects, in the form of a pressure, operation contents of the left traveling lever 26DL in a front-rear direction by an operator, and outputs the detected values to the controller 30. The operation pressure sensor 29DR detects, in the form of a pressure,

operation contents of the right traveling lever 26DR in a front-rear direction by an operator, and outputs the detected values to the controller 30.

[0063] The controller 30 receives outputs of the operation pressure sensor 29, and outputs a control command to the regulator 13, if necessary, to change the discharge amount of the main pump 14. Further, The controller 30 receives outputs of the control pressure sensor 19 that is provided on the upstream side of the aperture 18, and outputs a control command to the regulator 13, if necessary, to change the discharge amount of the main pump 14. The aperture 18 includes a left aperture 18L and a right aperture 18R, and the control pressure sensor 19 includes a left control pressure sensor 19L and the right control pressure sensor 19R.

[0064] In the left center bypass line 40, the left aperture 18L is provided between the control valve 176L, which is located in the most upstream, and the hydraulic oil tank. As a result, the flow of the hydraulic oil that is discharged from the left main pump 14L is limited by the left aperture 18L. Further, the left aperture 18L generates a control pressure for controlling the left regulator 13L. The left control pressure sensor 19L is a sensor for detecting the above-described control pressure, and outputs the detected value to the controller 30. The controller 30 controls the discharge amount of the left main pump 14L by adjusting the swash plate tilting angle of the left main pump 14L in accordance with the above described control pressure. The controller 30 reduces the discharge amount of the left main pump 14L as the control pressure is increased, and increases the discharge amount of the left main pump 14L as the control pressure is decreased. The discharge amount of the right main pump 14R is controlled in the same way.

[0065] Specifically, as illustrated in Fig. 3, in case of a standby state in which any of the hydraulic actuators in the shovel is not operated, the hydraulic oil discharged by the left main pump 14L goes through the left center bypass line 40L, and reaches the left aperture 18L. Further, the flow of the hydraulic oil that is discharged by the left main pump 14L increases the control pressure that is generated on the upstream side of the left aperture 18L. As a result, the controller 30 reduces the discharge amount of the left main pump 14L to the permissible minimum discharge amount, and reduces the pressure loss (pumping loss) when the discharged hydraulic oil passes through the left center bypass line 40L. On the other hand, in the case where any of the hydraulic actuators is operated, the hydraulic oil, which is discharged by the left main pump 14L, flows into the hydraulic actuator of the operation target via the control valve corresponding to the hydraulic actuator of the operation target. Further, the flow of the hydraulic oil discharged by the left main pump 14L causes the amount reaching the left aperture 18L to be reduced or to be vanished, and causes the control pressure generated on the upstream side of the left aperture 18L to be reduced. As a result, the controller 30 causes the discharge amount of the left main pump

14L to be increased, and causes sufficient amount of the hydraulic oil to flow into the hydraulic actuator of the operation target to ensure the drive of the oil actuator of the operation target. It should be noted that the controller 30 controls the discharge amount of the right main pump 14R in the same way.

[0066] According to the above arrangement, it is possible for the hydraulic system illustrated in Fig. 3 to reduce wasteful energy consumption at the main pump 14 in a standby state. The wasteful energy consumption includes pumping loss generated in the center bypass line 40 by the hydraulic oil discharged by the main pump 14. Further, it is possible for the hydraulic system illustrated in Fig. 3 to ensure supplying necessary and sufficient hydraulic oil from the main pump 14 to the hydraulic actuator of the operation target.

[0067] Next, referring to Fig. 4A to Fig. 4D, Fig. 5A and Fig. 5B, an arrangement will be described in which the controller 30 causes the actuators to operate using a machine control function. Fig. 4A to Fig. 4D are diagrams illustrating a part of the hydraulic system. Specifically, Fig. 4A is a diagram illustrating a part of the hydraulic system related to an operation of the arm cylinder 8, and Fig. 4B is a diagram illustrating a part of the hydraulic system related to an operation of the hydraulic swing motor 2A. Further, Fig. 4C is a drawing illustrating a part of the hydraulic system related to an operation of the boom cylinder 7, and Fig. 4D is a drawing illustrating a part of the hydraulic system related to an operation of the bucket cylinder 9. Similarly, Fig. 5A and Fig. 5B are diagrams illustrating a part of the hydraulic system. Specifically, Fig. 4A is a diagram illustrating a part of the hydraulic system related to an operation of the left hydraulic traveling motor 2ML, and Fig. 4B is a diagram illustrating a part of the hydraulic system related to an operation of the right hydraulic traveling motor 2MR.

[0068] As illustrated in Fig. 4A to Fig. 4D, Fig. 5A and Fig. 5B, the hydraulic system includes a proportional valve 31 and a shuttle valve 32. The proportional valve 31 includes proportional valves 31AL to 31FL and 31AR to 31FR, and the shuttle valve 32 includes shuttle valves 32AL to 32FL and 32AR to 32FR.

[0069] The proportional valve 31 is configured to function as a machine control valve. The proportional valve 31 is provided in a line that connects the pilot pump 15 and the shuttle valve 32, and is configured to change the flowing line area of the line. In an embodiment of the present invention, the proportional valve 31 operates in response to a control command output by the controller 30. Therefore, it is possible for the controller 30 to supply hydraulic oil discharged by the pilot pump 15 to the pilot port of the corresponding control valve in the control valve 17 via the proportional valve 31 and the shuttle valve 32, regardless of the operation of the operation device 26 by the operator.

[0070] The shuttle valve 32 has two inlet ports and one outlet port. One of the two inlet ports is connected to the operation device 26 and the other is connected to the

proportional valve 31. The outlet port is connected to a pilot port of a corresponding control valve in the control valve 17. Therefore, the shuttle valve 32 can cause the higher of: the pilot pressure generated by the operation device 26; and the pilot pressure generated by the proportional valve 31, to act on the pilot port of the corresponding control valve.

[0071] According to the above arrangement, it is possible for the controller 30 to cause the hydraulic actuator corresponding to the specific operation device 26, even in the case where no operation is performed on the specific operation device 26.

[0072] For example, as illustrated in Fig. 4A, the left operation lever 26L is used for operating the arm 5. Specifically, the left operation lever 26L uses hydraulic oil discharged by the pilot pump 15 to apply a pilot pressure, which corresponds to the operation in the front-rear direction, to the pilot port of the control valve 176. More specifically, in the case where the left operation lever 26L is operated in an arm-close direction (rearward direction), the left operation lever 26L applies a pilot pressure, which corresponds to the operation amount, to a right-side pilot port of the control valve 176L and to a left-side pilot port of the control valve 176R. Further, in the case where the left operation lever 26L is operated in an arm-open direction, the left operation lever 26L applies a pilot pressure, which corresponds to the operation amount, to a left-side pilot port of the control valve 176L and to a right-side pilot port of the control valve 176R.

[0073] The left operation lever 26L is provided with a switch NS. In an embodiment of the present invention, the switch NS is a push-button switch. It is possible for an operator to operate the left operation lever 26L with a hand while pushing the switch NS with a finger. The switch NS may be provided in the right operation lever 26R, or may be provided at another location in the cabin 10.

[0074] The operation pressure sensor 29LA detects, in the form of a pressure, operation contents of the left operation lever 26L in a front-rear direction by an operator, and outputs the detected values to the controller 30.

[0075] The proportional valve 31AL operates in response to a current command output by the controller 30. Further, the proportional valve 31AL adjusts a pilot pressure that is generated by hydraulic oil that is introduced from the pilot pump 15 to the right-side pilot port of the control valve 176L and to the left-side pilot port of the control valve 176R via the proportional valve 31AL and the shuttle valve 32AL. The proportional valve 31AR operates in response to a current command output by the controller 30. Further, the proportional valve 31AR adjusts a pilot pressure that is generated by hydraulic oil that is introduced from the pilot pump 15 to the left-side pilot port of the control valve 176L and to the right-side pilot port of the control valve 176R via the proportional valve 31AR and the shuttle valve 32AR. Each of the proportional valves 31AL and 31AR is capable of adjusting the pilot pressure so that the control valve 176 is stopped

at any valve position.

[0076] According to the above arrangement, it is possible for the controller 30 to supply hydraulic oil discharged by the pilot pump 15 to the right-side pilot port of the control valve 176L and to the left-side pilot port of the control valve 176R via the proportional valve 31AL and the shuttle valve 32AL, regardless of the arm-close operation by an operator. In other words, it is possible for the controller 30 to close the arm 5, regardless of the arm-close operation by an operator. Further, it is possible for the controller 30 to supply hydraulic oil discharged by the pilot pump 15 to the left-side pilot port of the control valve 176L and to the right-side pilot port of the control valve 176R via the proportional valve 31AR and the shuttle valve 32AR, regardless of the arm-open operation by an operator. In other words, it is possible for the controller 30 to open the arm 5, regardless of the arm-open operation by an operator.

[0077] Further, as illustrated in Fig. 4B, the left operation lever 26L is also used for operating the swing mechanism 2. Specifically, the left operation lever 26L uses hydraulic oil discharged by the pilot pump 15 to apply a pilot pressure, which corresponds to the operation in the left-right direction, to the pilot port of the control valve 173. More specifically, in the case where the left operation lever 26L is operated in a left swing direction (left direction), the left operation lever 26L applies a pilot pressure, which corresponds to the operation amount, to a left-side pilot port of the control valve 173. Further, in the case where the left operation lever 26L is operated in a right swing direction (right direction), the left operation lever 26L applies a pilot pressure, which corresponds to the operation amount, to a right-side pilot port of the control valve 173.

[0078] The operation pressure sensor 29LB detects, in the form of a pressure, operation contents of the left operation lever 26L in a left-right direction by an operator, and outputs the detected values to the controller 30.

[0079] The proportional valve 31BL operates in response to a current command output by the controller 30. Further, the proportional valve 31BL adjusts a pilot pressure that is generated by hydraulic oil that is introduced from the pilot pump 15 to the left-side pilot port of the control valve 173 via the proportional valve 31BL and the shuttle valve 32BL. The proportional valve 31BR operates in response to a current command output by the controller 30. Further, the proportional valve 31BR adjusts a pilot pressure that is generated by hydraulic oil that is introduced from the pilot pump 15 to the right-side pilot port of the control valve 173 via the proportional valve 31BR and the shuttle valve 32BR. Each of the proportional valves 31BL and 31BR is capable of adjusting the pilot pressure so that the control valve 173 is stopped at any valve position.

[0080] According to the above arrangement, it is possible for the controller 30 to supply hydraulic oil discharged by the pilot pump 15 to the left-side pilot port of the control valve 173 via the proportional valve 31BL and

the shuttle valve 32BL, regardless of the left swing operation by an operator. In other words, it is possible for the controller 30 to cause the swing mechanism 2 to swing left, regardless of the swing-left operation by an operator. Further, it is possible for the controller 30 to supply hydraulic oil discharged by the pilot pump 15 to the right-side pilot port of the control valve 173 via the proportional valve 31BR and the shuttle valve 32BR, regardless of the swing-right operation by an operator. In other words, it is possible for the controller 30 to cause the swing mechanism 2 to swing right, regardless of the swing-right operation by an operator.

[0081] Further, as illustrated in Fig. 4C, the right operation lever 26R is used for operating the boom 4. Specifically, the right operation lever 26R uses hydraulic oil discharged by the pilot pump 15 to apply a pilot pressure, which corresponds to the operation in the front-rear direction, to the pilot port of the control valve 175. More specifically, in the case where the right operation lever 26R is operated in a boom up direction (rearward direction), the right operation lever 26R applies a pilot pressure, which corresponds to the operation amount, to a right-side pilot port of the control valve 175L and to a left-side pilot port of the control valve 175R. Further, in the case where the right operation lever 26R is operated in a boom down direction (forward direction), the right operation lever 26R applies a pilot pressure, which corresponds to the operation amount, to a right-side pilot port of the control valve 175R.

[0082] The operation pressure sensor 29RA detects, in the form of a pressure, operation contents of the right operation lever 26R in a front-rear direction by an operator, and outputs the detected values to the controller 30.

[0083] The proportional valve 31CL operates in response to a current command output by the controller 30. Further, the proportional valve 31CL adjusts a pilot pressure that is generated by hydraulic oil that is introduced from the pilot pump 15 to the right-side pilot port of the control valve 175L and to the left-side pilot port of the control valve 175R via the proportional valve 31CL and the shuttle valve 32CL. The proportional valve 31CR operates in response to a current command output by the controller 30. Further, the proportional valve 31CR adjusts a pilot pressure that is generated by hydraulic oil that is introduced from the pilot pump 15 to the left-side pilot port of the control valve 175L and to the right-side pilot port of the control valve 175R via the proportional valve 31CR and the shuttle valve 32CR. Each of the proportional valves 31CL and 31CR is capable of adjusting the pilot pressure so that the control valve 175 is stopped at any valve position.

[0084] According to the above arrangement, it is possible for the controller 30 to supply hydraulic oil discharged by the pilot pump 15 to the right-side pilot port of the control valve 175L and to the left-side pilot port of the control valve 175R via the proportional valve 31CL and the shuttle valve 32CL, regardless of the boom up operation by an operator. In other words, it is possible

for the controller 30 to move up the boom 4, regardless of the boom up operation by an operator. Further, it is possible for the controller 30 to supply hydraulic oil discharged by the pilot pump 15 to the right-side pilot port of the control valve 175R via the proportional valve 31CR and the shuttle valve 32CR, regardless of a boom down operation by an operator. In other words, it is possible for the controller 30 to move down the boom 4, regardless of the boom down operation by an operator.

[0085] Further, as illustrated in Fig. 4D, the right operation lever 26R is also used for operating the bucket 6. Specifically, the right operation lever 26R uses hydraulic oil discharged by the pilot pump 15 to apply a pilot pressure, which corresponds to the operation in the left-right direction, to the pilot port of the control valve 174. More specifically, in the case where the right operation lever 26R is operated in a bucket close direction (left direction), the right operation lever 26R applies a pilot pressure, which corresponds to the operation amount, to a left-side pilot port of the control valve 174. Further, in the case where the right operation lever 26R is operated in a bucket open direction (right direction), the right operation lever 26R applies a pilot pressure, which corresponds to the operation amount, to a right-side pilot port of the control valve 174.

[0086] The operation pressure sensor 29RB detects, in the form of a pressure, operation contents of the right operation lever 26R in a left-right direction by an operator, and outputs the detected values to the controller 30.

[0087] The proportional valve 31DL operates in response to a current command output by the controller 30. Further, the proportional valve 31DL adjusts a pilot pressure that is generated by hydraulic oil that is introduced from the pilot pump 15 to the left-side pilot port of the control valve 174 via the proportional valve 31DL and the shuttle valve 32DL. The proportional valve 31DR operates in response to a current command output by the controller 30. Further, the proportional valve 31DR adjusts a pilot pressure that is generated by hydraulic oil that is introduced from the pilot pump 15 to the right-side pilot port of the control valve 174 via the proportional valve 31DR and the shuttle valve 32DR. Each of the proportional valves 31DL and 31DR is capable of adjusting the pilot pressure so that the control valve 174 is stopped at any valve position.

[0088] According to the above arrangement, it is possible for the controller 30 to supply hydraulic oil discharged by the pilot pump 15 to the left-side pilot port of the control valve 174 via the proportional valve 31DL and the shuttle valve 32DL, regardless of the bucket close operation by an operator. In other words, it is possible for the controller 30 to close the bucket 6, regardless of the bucket close operation by an operator. Further, it is possible for the controller 30 to supply hydraulic oil discharged by the pilot pump 15 to the right-side pilot port of the control valve 174 via the proportional valve 31ER and the shuttle valve 32DR, regardless of a bucket open operation by an operator. In other words, it is possible

for the controller 30 to open the bucket 6, regardless of the bucket-open operation by an operator.

[0089] Further, as illustrated in Fig. 5A, the left traveling lever 26DL is used for operating the left crawler 1CL. Specifically, the left traveling lever 26DL uses hydraulic oil discharged by the pilot pump 15 to apply a pilot pressure, which corresponds to the operation in the front-rear direction, to the pilot port of the control valve 171. More specifically, in the case where the left traveling lever 26DL is operated in a move forward direction (forward direction), the left traveling lever 26DL applies a pilot pressure, which corresponds to the operation amount, to a left-side pilot port of the control valve 171. Further, in the case where the left traveling lever 26DL is operated in a move backward direction (backward direction), the left traveling lever 26DL applies a pilot pressure, which corresponds to the operation amount, to a right-side pilot port of the control valve 171.

[0090] The operation pressure sensor 29DL detects, in the form of a pressure, operation contents of the left traveling lever 26DL in a front-rear direction by an operator, and outputs the detected values to the controller 30.

[0091] The proportional valve 31EL operates in response to a current command output by the controller 30. Further, the proportional valve 31EL adjusts a pilot pressure that is generated by hydraulic oil that is introduced from the pilot pump 15 to the left-side pilot port of the control valve 171 via the proportional valve 31EL and the shuttle valve 32EL. The proportional valve 31ER operates in response to a current command output by the controller 30. Further, the proportional valve 31ER adjusts a pilot pressure that is generated by hydraulic oil that is introduced from the pilot pump 15 to the right-side pilot port of the control valve 171 via the proportional valve 31ER and the shuttle valve 32ER. Each of the proportional valves 31EL and 31ER is capable of adjusting the pilot pressure so that the control valve 171 is stopped at any valve position.

[0092] According to the above arrangement, it is possible for the controller 30 to supply hydraulic oil discharged by the pilot pump 15 to the left-side pilot port of the control valve 171 via the proportional valve 31EL and the shuttle valve 32EL, regardless of a left move-forward operation by an operator. In other words, it is possible for the controller 30 to move forward the left crawler 1CL, regardless of the left move-forward operation by an operator. Further, it is possible for the controller 30 to supply hydraulic oil discharged by the pilot pump 15 to the right-side pilot port of the control valve 171 via the proportional valve 31ER and the shuttle valve 32ER, regardless of a left move-backward operation by an operator. In other words, it is possible for the controller 30 to move backward the left crawler 1CL, regardless of the left move-backward operation by an operator.

[0093] Further, as illustrated in Fig. 5B, the right traveling lever 26DR is used for operating the right crawler 1CR. Specifically, the right traveling lever 26DR uses hydraulic oil discharged by the pilot pump 15 to apply a

pilot pressure, which corresponds to the operation in the front-rear direction, to the pilot port of the control valve 172. More specifically, in the case where the right traveling lever 26DR is operated in a move forward direction (forward direction), the right traveling lever 26DR applies a pilot pressure, which corresponds to the operation amount, to a right-side pilot port of the control valve 172. Further, in the case where the right traveling lever 26DR is operated in a move backward direction (backward direction), the right traveling lever 26DR applies a pilot pressure, which corresponds to the operation amount, to a left-side pilot port of the control valve 172.

[0094] The operation pressure sensor 29DR detects, in the form of a pressure, operation contents of the right traveling lever 26DR in a front-rear direction by an operator, and outputs the detected values to the controller 30.

[0095] The proportional valve 31FL operates in response to a current command output by the controller 30. Further, the proportional valve 31FL adjusts a pilot pressure that is generated by hydraulic oil that is introduced from the pilot pump 15 to the left-side pilot port of the control valve 172 via the proportional valve 31FL and the shuttle valve 32FL. The proportional valve 31FR operates in response to a current command output by the controller 30. Further, the proportional valve 31FR adjusts a pilot pressure that is generated by hydraulic oil that is introduced from the pilot pump 15 to the right-side pilot port of the control valve 172 via the proportional valve 31FR and the shuttle valve 32FR. Each of the proportional valves 31FL and 31FR is capable of adjusting the pilot pressure so that the control valve 172 is stopped at any valve position.

[0096] According to the above arrangement, it is possible for the controller 30 to supply hydraulic oil discharged by the pilot pump 15 to the right-side pilot port of the control valve 172 via the proportional valve 31FL and the shuttle valve 32FL, regardless of a right move-forward operation by an operator. In other words, it is possible for the controller 30 to move forward the right crawler 1CR, regardless of the right move-forward operation by an operator. Further, it is possible for the controller 30 to supply hydraulic oil discharged by the pilot pump 15 to the left-side pilot port of the control valve 172 via the proportional valve 31FR and the shuttle valve 32FR, regardless of a right move-backward operation by an operator. In other words, it is possible for the controller 30 to move backward the right crawler 1CR, regardless of the right move-backward operation by an operator.

[0097] It should be noted that, although a hydraulic operation lever with a hydraulic pilot circuit is employed in the above-described embodiment, an electric operation lever with an electric pilot circuit may be employed instead of the hydraulic operation lever with a hydraulic pilot circuit. In this case, the lever operation amount of the electric operation lever is input the controller 30 as an electric signal. Further, an electromagnetic valve (solenoid valve) is provided between the pilot pump 15 and a pilot port of each control valve. The electromagnetic

valve is configured to operate in response to an electric signal from the controller 30. According to the above arrangement, when an manual operation is performed by using the electric operation lever, it is possible for the controller 30 to move each control valve by controlling the electromagnetic valve by an electric signal corresponding to the lever operation amount to increase or reduce the pilot pressure to move each control valve. It should be noted that each control valve may be formed by an electromagnetic spool valve (solenoid spool valve). In this case, the electromagnetic valve operates in response to an electric signal, corresponding to the lever operation amount of the electric operation lever, from the controller 30.

[0098] Next, referring to Fig. 6, functions of the controller 30 will be described. Fig. 6 is a functional block diagram illustrating a configuration example of the controller 30. In an example of Fig. 3, the controller 30 is configured to: receive a signal output by at least one of the posture detection device, the operation device 26, the space recognition device 70, the orientation detection device 71, the information input device 72, the positioning device 73, the switch NS, etc.; to perform various calculations; and to output a control command to at least one of the proportional valve 31, the display device D1, the sound output device D2, etc. The posture detection device includes the boom angle sensor S1, the arm angle sensor S2, the bucket angle sensor S3, the device body inclination sensor S4, and the swing angular velocity sensor S5. The controller 30 includes, as functional elements responsible for various functions, a posture detection unit 30A, a determination unit 30B, and an autonomous control unit 30C. Each functional element may be made by hardware, or may be made by software.

[0099] The posture detection unit 30A is configured to detect information related to a posture of the shovel 100. In an embodiment of the present invention, the posture detection unit 30A detects information related to the posture of the shovel 100 based on an output of the posture detection device. The posture detection unit 30A may detect, as the posture of the shovel 100, the posture of the excavating attachment AT based on an output of the posture detection device. Further, the posture detection unit 30A may detect, as the posture of the shovel 100, the posture of the upper-part swing body 3 (an orientation of the upper-part swing body 3 relative to an orientation of the lower-part traveling body 1) based on at least one of the posture detection device and the orientation detection device.

[0100] The determination unit 30B is configured to determine whether a desired space exists or not. In an embodiment of the present invention, the determination unit 30B is configured to determine: whether a parking space, in which the shovel 100 can park, exists or not; and whether a passing space, through which the shovel 100 can pass, exists or not. In other words, the determination unit 30B is configured to determine: whether there exists a space that is larger than the body of the shovel 100 in a

space specified as a parking space; or, whether there exist continual spaces that are larger than the body of the shovel 100 (that allow the body of the shovel 100 to pass) on the route from the current location to the space specified as the parking space. Specifically, the determination unit 30B determines whether there exists a parking space based on an output of the space recognition device 70. Further, in the case where the determination unit 30B determines that there exists a parking space, the determination unit 30B determines whether there exists a passing space used for moving the shovel 100 from the current location to the parking space without causing the shovel 100 to touch an external object. Further, in the case where the determination unit 30B determines that there exists a passing space, the determination unit 30B determines that the shovel can be moved to the parking space and that the shovel 100 can be parked.

[0101] The autonomous control unit 30C is configured to autonomously operate the shovel 100. In an embodiment of the present invention, the autonomous control unit 30C is configured to calculate a target trajectory from the current location of the shovel 100 to the parking space, and to cause the shovel 100 to move along the target trajectory. The target trajectory is a trajectory that is drawn by a predetermined part of the shovel 100 when the shovel 100 autonomously moves. The target trajectory includes, for example, a target trajectory related to the crawler 1C. In this case, the predetermined part is, for example, a front end or a rear end of the crawler 1C. The target trajectory may include, for example, a target trajectory related to the excavating attachment AT. In this case, the predetermined part is, for example, a top end of the boom 4. The target trajectory may be a trajectory drawn by a center point of the shovel 100 as the predetermined part. The center point of the shovel 100 is typically a point on the swing axis. Alternatively, the target trajectory may be a trajectory, with a width, drawn by the outline of the shovel 100 moving from the current location to the parking space.

[0102] The target trajectory is calculated, for example, so that the shovel 100 is moved to a specific parking space and is caused to park. In this case, the target trajectory is calculated by taking into account the movement that can be realized by the shovel 100. Further, the autonomous control unit 30C determines how to operate actuators based on the calculated target trajectory. For example, when causing the shovel 100 to move backward, the autonomous control unit 30C selects an appropriate moving method from a spin turn, a pivot turn, a slow turn, and a moving straight, and determines how to operate the hydraulic traveling motor 2M. In this case, the autonomous control unit 30C may determine, not only the necessity of operating the traveling driving unit such as the hydraulic traveling motor 2M, but also the necessity of operating the swing mechanism 2. Further, the autonomous control unit 30C may determine whether there is a risk that the attachment may touch peripheral equipment or other construction machines, and may de-

termine the necessity of operating the attachment.

[0103] Next, referring to Fig. 7, a process (hereinafter, referred to as "parking process") of moving, by the controller 30, the shovel 100 and causing the shovel 100 to park, will be described. Fig. 7 is a flowchart illustrating an example of the parking process.

[0104] First, the controller 30 determines whether a parking mode button is pushed (step ST1). In an embodiment of the present invention, the controller 30 performs this determination repeatedly for each predetermined control cycle. The parking mode button is, for example, a switch NS that is provided on the top end of the left operation lever 26L. The parking mode button may be a software button that is displayed by the display device D1 with a touch panel. The controller 30 repeats this determination until the controller 30 determines that the parking mode button is pushed (NO in step ST1).

[0105] In the case when it is determined that the parking mode button is pushed (YES in step ST1), the controller 30 displays a setting screen (step ST2). In an embodiment of the present invention, the controller 30 displays, as the setting screen, a parking space selection screen on the display device D1.

[0106] Fig. 8 is a drawing illustrating a configuration example of the parking space selection screen. A parking space selection screen GA includes a shovel graphic G1 and a parking space graphic G2. The parking space selection screen illustrated in Fig. 8 may be displayed by a display device installed in a support device including a mobile terminal such as a smart phone, possessed by the operator. In this case, the support device may function as a communication device, and may control communications with the shovel via a near field communication network such as Wi-Fi (registered trademark), Bluetooth (registered trademark), wireless LAN, or the like, a mobile phone communication network, a satellite communication network, etc.

[0107] The shovel graphic G1 and the parking space graphic G2 indicate a locational relation between the upper-part swing body 3 and the parking space. In an embodiment of the present invention, the shovel graphic G1 represents a shape of the upper-part swing body 3 viewed from directly above the upper-part swing body 3. The parking space graphic G2 represents an approximate location, with respect to the upper-part swing body 3, of a space that can be set as a parking space. Specifically, the parking space graphic G2 includes: a right parking space graphic G2R representing a space located on the right side of the upper-part swing body 3; a front parking space graphic G2F representing a space located on the front side of the upper-part swing body 3; a left parking space graphic G2L representing a space located on the left side of the upper-part swing body 3; and a rear parking space graphic G2B representing a space located on the rear side of the upper-part swing body 3. It should be noted, however, that the parking space graphic G2 may include five or more parking space figures including at least one of a right-sided front parking space figure, a

left-sided front parking space figure, a right-sided rear parking space figure, a left-sided rear parking space figure, etc. Further, the parking space graphic G2 may represent a more precise location, with respect to the upper-part swing body 3, of a space that can be set as a parking space. Alternatively, the parking space graphic G2 may only correspond to a parking space that is recognized by the space recognition device 70. In this case, if, for example, the controller 30 determines that there exists no parking space on the left side of the upper-part swing body 3, then the controller 30 may not display the left parking space graphic G2L.

[0108] The parking space graphic G2 may be superimposed on a camera image. The camera image is, for example, a bird's eye image as a view conversion image that is generated based on images captured by a plurality of cameras attached to the upper-part swing body 3. In this case, the bird's eye image is displayed around the shovel graphic G1.

[0109] Further, the parking space selection screen GA may be: a screen related to a view when viewing backward from the shovel 100; or a screen related to a view when viewing the side from the shovel 100, instead of a screen related to a view that is viewed from directly above the shovel 100 as described above.

[0110] An operator of the shovel 100 selects a parking space graphic G2 that includes a space in which the shovel is to be parked while looking at the parking space selection screen GA.

[0111] Thereafter, the controller 30 determines whether a target parking space is determined (step ST3). An operator of the shovel 100 presses the parking mode button in the cabin 10 of the shovel 100 located at a location illustrated in Fig. 9, for example. Fig. 9 is a top view of an actual parking lot at a construction site or at a garage (parking apron). When the parking mode button is pushed, the controller 30 displays the parking space selection screen GA. At this time, it is possible for an operator to set, as a target parking space, a space SP in the actual parking lot by selecting the right parking space graphic G2R.

[0112] In an example of Fig. 9, when the left parking space graphic G2L is selected, the determination unit 30B of the controller 30 determines whether there exists a space, in which the shovel 100 can be parked, on the left side of the upper-part swing body 3, based on an output of the space recognition device 70. In an example of Fig. 9, there is a wall on the left side of the upper-part swing body 3, and there exists no space in which the shovel 100 can be parked. In this case, the determination unit 30B may determine that there exists no space in which the shovel 100 can be parked on the left side of the upper-part swing body 3, and may display a text message indicating the same on the parking space selection screen GA.

[0113] Similarly, when the right parking space graphic G2R is selected, the determination unit 30B determines whether there exists a space, in which the shovel 100

can be parked, on the right side of the upper-part swing body 3, based on an output of the space recognition device 70.

[0114] In an example of Fig. 9, the space SP specified as the parking space is a space larger than the body of the shovel 100. In other words, there exists a space SP in which the shovel 100 can be parked on the right side of the upper-part swing body 3. The controller 30 recognizes the specified space SP as the end point of the target trajectory. Therefore, it is possible for the controller 30 to stop the traveling of the shovel 100 at the specified space SP even if there exists another space farther than the specified space SP.

[0115] In this case, the determination unit 30B determines that there exists a space SP in which the shovel 100 can be parked on the right side of the upper-part swing body 3. In the case where the determination unit 30B determines that there exists the space SP, the determination unit 30B determines whether there exists a passing space used for moving the shovel 100 from the current location to the space SP. In other words, the determination unit 30B determines whether there exist continual spaces that are larger than the body of the shovel 100 (that allow the body of the shovel 100 to pass) on the route from the current location to the specified space SP.

[0116] In the case where the determination unit 30B determines that the passing space cannot be secured because of a reason that there exists an obstacle between the current location and the space SP, etc., the determination unit 30B may determine that the shovel 100 cannot be moved to the space SP, and may display a text message indicating the same on the parking space selection screen GA. In the case where the determination unit 30B determines that the passing space can be secured, the determination unit 30B sets the space SP as the target parking space.

[0117] In the case where it is determined that the target parking space has not been set (NO in step ST3), the controller 30 repeats the determination of step ST3 until the target parking space is set.

[0118] In the case when it is determined that the target parking space is set (YES in step ST3), the controller 30 adjusts the posture of an attachment (step ST4). In an embodiment of the present invention, the autonomous control unit 30C of the controller 30 changes the posture of the excavating attachment AT to a posture suitable for traveling (hereinafter, referred to as "traveling posture"). The traveling posture is a pre-registered posture, and is, for example, a posture in which the boom angle θ_1 is the maximum, the arm angle θ_2 and the bucket angle θ_3 are the minimum. Specifically, in the case where the posture detection unit 30A determines that the detected posture of the excavating attachment AT is not the traveling posture, the autonomous control unit 30C changes the posture of the excavating attachment AT to the traveling posture.

[0119] In an embodiment of the present invention, the

controller 30 is configured based on the assumption that, basically, an operator of the shovel 100 does not operate the operation device 26 while processes of step ST4 and later are being performed. Therefore, the shovel 100 may be configured in such a way that an operation of the operation device 26 by an operator is disabled excluding an operation for forcibly terminating the parking process. The operation for forcibly terminating the parking process is, for example, a re-operation of the parking mode button. Further, an operator of the shovel 100 may perform operations related to processes up to step ST3 from outside of the cabin 10. In this case, while the processes of step ST4 and later are being performed, it is possible for an operator of the shovel 100 to monitor the operation of the shovel 100 from outside the cabin 10, and to forcibly terminate the parking process if necessary by an operation from a mobile terminal, etc.

[0120] Thereafter, the autonomous control unit 30C determines the target trajectory (step ST5). In an example of FIG. 9, the autonomous control unit 30C determines the trajectory drawn by the rear end of the crawler 1C as the shovel 100 moves from the current location to the space SP. Further, the autonomous control unit 30C determines the space SP as the end point of the target trajectory. At this time, the order of operations of the crawler 1C based on the necessity of turns is also determined. The order of operations of the crawler 1C may include, for example, the order of operations of the left hydraulic traveling motor 2ML and the order of operations of the right hydraulic traveling motor 2MR.

[0121] Thereafter, the autonomous control unit 30C causes the shovel 100 to move along the determined target trajectory (step ST6). In an example of Fig. 9, the autonomous control unit 30C first performs a spin turn of about 45 degrees in a counterclockwise direction and causes the rear end of the crawler 1C to face the space SP based on the determined movement of the crawler 1C. Specifically, the autonomous control unit 30C performs the spin turn in a counterclockwise direction by causing the right hydraulic traveling motor 2MR to rotate in a forward direction and by causing the left hydraulic traveling motor 2ML to rotate in a reverse direction. Subsequently, the autonomous control unit 30C performs a slow turn, while causing the shovel 100 to move backward along the target trajectory that is slowly curved counterclockwise, causes the orientation of the lower-part traveling body 1 to be the same orientation as other shovels that are parked around the shovel 100. Specifically, the autonomous control unit 30C performs the slow turn in a counterclockwise direction by causing the left hydraulic traveling motor 2ML to rotate in the reverse direction at a rotation speed faster than the reverse rotation speed of the right hydraulic traveling motor 2MR. Thereafter, the autonomous control unit 30C causes the shovel 100 to move straight backward and causes the entire shovel 100 to enter the space SP. Specifically, the autonomous control unit 30C causes the shovel 100 to move straight backward by causing the right hydraulic

traveling motor 2MR and the left hydraulic traveling motor 2ML to rotate in the reverse direction at the same rotation speed.

[0122] When moving the crawler 1C, the autonomous control unit 30C may change the posture of the excavating attachment AT as necessary. For example, in the case where it is determined there is a risk that the excavating attachment AT may touch an electrical wire (power line) that is extended at a higher location than the cabin 10 if the shovel 100 moves backward, the boom 4 may be lowered. In this case, the autonomous control unit 30C may recognize an obstacle such as an electrical wire based on an output of the space recognition device 70. Further, after passing through under the electrical wire, the autonomous control unit 30C may raise the boom 4 and return the posture of the excavating attachment AT to the traveling posture.

[0123] Further, When moving the crawler 1C, the autonomous control unit 30C may cause the upper-part swing body 3 to swing as necessary. For example, in an example of Fig. 9, if the autonomous control unit 30C performs a spin turn of 45 degrees or more in a counterclockwise direction without causing the upper-part swing body 3 to swing, there is a risk that the excavating attachment AT may touch the wall W. In this case, the autonomous control unit 30C may prevent the excavating attachment AT from touching the wall W by causing the upper-part swing body 3 to swing in a clockwise direction before or during the spin turn. It should be noted that the autonomous control unit 30C may recognize the existence of an obstacle such as the wall W based on an output of the space recognition device 70, for example.

[0124] Thereafter, the autonomous control unit 30C causes the attachment to touch the ground in the target parking space (step ST7). In an example of Fig. 9, the autonomous control unit 30C causes the movement of the crawler 1C to stop after causing the entire shovel 100 to enter the space SP, and changes the posture of the excavating attachment AT to a posture suitable for parking (hereinafter, referred to as "parking posture"). The parked posture is a pre-registered posture, and is, for example, a posture in which the bucket 6 is in contact with the ground surface. It should be noted, however, that the parking posture may be the same as the traveling posture, or may be another posture in which the excavating attachment AT is not in contact with the ground surface. Further, the parking posture may be configured to be selected from a plurality of postures. The same applies to the traveling posture.

[0125] Thereafter, the autonomous control unit 30C notifies the parking completion (step ST8). In an embodiment of the present invention, at the time when the posture of the excavating attachment AT is changed to the parking posture, the autonomous control unit 30C causes the display device D1 to display information indicating the parking completion and causes the sound output device D2 to output information indicating the parking completion.

[0126] Next, referring to Fig. 10, another example of a parking space selection screen will be described. Fig. 10 is a drawing illustrating another configuration example of the parking space selection screen. The parking space selection screen GB includes map figures including information related to arrangement of other construction machines in the parking lot, a depot, an office, etc., and a parking space graphic GS. The depot is, for example, a place used for loading the shovel 100 onto a transporting vehicle such as a trailer or for unloading the shovel 100 from the transporting vehicle.

[0127] The parking space graphic GS indicates a location of a parking space that can be selected as a parking space used for parking the shovel 100. In an example of Fig. 10, the parking space graphic GS includes 27 parking space graphics GS1 to GS27. Specifically, the parking space graphic GS illustrated in Fig. 10 corresponds to the parking lot illustrated in Fig. 11. Fig. 11 is a top view of an actual parking lot. The parking lot illustrated in Fig. 11 is a parking lot owned by a construction machine rental company, for example, and includes three parking space rows, each of the parking space rows allowing nine shovels to park. In the parking lot illustrated in Fig. 11, at present, eighteen shovels are parked other than the shovel 100 that has just unloaded from a trailer. In an example of Fig. 11, location information related to each parking space is pre-registered. The location information related to each parking space includes, for example, a latitude, a longitude and an altitude of a center point of each parking space.

[0128] As illustrated in Fig. 10, the controller 30 may display the parking space graphic GS in such a way that an operator can distinguish between: the parking space graphic GS related to parking spaces that are already parked by other construction machines, such as shovels, bulldozers, wheel loaders, cranes, road rollers, etc.; and the parking space graphic GS related to parking spaces that are not parked by other construction machines. In an example of Fig. 10, dot-hatching is applied to the parking space graphic GS related to parking spaces that are already parked by other construction machines. On the other hand, dot-hatching is not applied to the parking space graphic GS related to parking spaces that are not parked by other construction machines.

[0129] In this case, in each construction machine such as a shovel, a wheel loader, etc., a device such as a GNSS receiver that is capable of identifying location information is installed. Further, the location information of each construction machine is transmitted from each construction machine to a management device that is provided in an office, etc., via a communication network such as a near field radio communication network, a mobile phone communication network, a satellite communication network, etc. According to the above, it is possible for the management device to obtain current location information of each construction machine and obtain arrangement information in the parking lot. Further, it is possible for the management device to transmit the ar-

rangement information to the shovel 100 that is going to be parked in the parking lot. According to the above, it is possible for an operator of the shovel 100 to check the parking space selection screen GB illustrated in Fig. 10 on the display device D1 provided inside of the cabin 10. Further, the parking space selection screen illustrated in Fig. 10 may be displayed by a display device D1 of the management device. Further, the parking space selection screen illustrated in Fig. 10 may be displayed by a display device D1 of a support device including a mobile terminal such as a smart phone, possessed by the operator.

[0130] In a situation described above, the operator of the shovel 100 selects, while looking at the parking space selection screen GB inside or outside of the cabin 10, a parking space graphic GS corresponding to a parking space for the shovel 100 to be parked, by a touch operation, etc. As illustrated in Fig. 10, the controller 30 may display the parking space selection screen GB in such a way that the operator can distinguish between the parking space graphic GS selected by the operator and other parking space graphics GS. In an example of Fig. 10, diagonal-hatching is applied to the parking space graphic GS26 that is selected by the operator.

[0131] In this way, it is possible for an operator of the shovel 100 to set, as a target parking space, a space SP in an actual parking lot illustrated in Fig. 11 by selecting the parking space graphic GS26.

[0132] In the case where it is determined that the target parking space is set, the autonomous control unit 30C of the controller 30 generates a trajectory from the current location to the specified space based on the arrangement information, and operates at least one of the left hydraulic traveling motor 2ML and the right hydraulic traveling motor 2MR. Further, the autonomous control unit 30C, while comparing an output of the positioning device 73 with the generated trajectory, operates at least one of the left hydraulic traveling motor 2ML and the right hydraulic traveling motor 2MR, and moves the shovel 100 to close to the target parking space. In an example of Fig. 11, the autonomous control unit 30C moves the shovel 100 along a traveling route TR illustrated by a dashed line. The generation of the trajectory from the current location to the specified space based on the arrangement information may be performed by the management device. When moving the shovel 100, as described above, the autonomous control unit 30C may change the posture of the excavating attachment AT as necessary so that the shovel 100 does not touch other objects, or may cause the upper-part swing body 3 to swing.

[0133] Next, referring to Fig. 12, yet another example of a parking space selection screen will be described. Fig. 12 illustrates a parking space selection screen GC that is a yet another configuration example of the parking space selection screen. The parking space selection screen GC includes graphics G10 to G15. The graphic G10 represents the shovel 100 that is going to be parked by an operator. The graphic G11 represents a shovel that

is already parked. In an example illustrated in Fig. 12, the display device D1 displays eighteen graphics G11 representing respective eighteen shovels that are already parked. In Fig. 12, one of the eighteen graphics G11 is specified using a drawing line.

[0134] A graphic G12 represents a parking space that can be used for the shovel 100 to be parked. In an example illustrated in Fig. 12, the display device D1 displays four graphics G12 (graphics G12A to G12D) representing respective selectable parking spaces. Further, the display device D1 displays the selectable parking spaces in such a way that the operator can distinguish between the selected parking space and unselected parking spaces among the selectable parking spaces, by causing at least one of the color, pattern, etc., of the graphics G12 to vary. Specifically, the display device D1 indicates that the parking space represented by the graphic G12D is selected by the operator. It is possible for the operator to select a desired parking space by touching a portion corresponding to the desired parking space on the touch panel attached to the display device D1.

[0135] A graphic G13 indicates a process flow until the start of autonomous traveling of the shovel 100. In an example of Fig. 12, the display device D1 indicates that the autonomous traveling of the shovel 100 starts after the parking space selection and the route selection, by displaying three text labels "parking space selection", "route selection", and "start traveling". Further, the display device D1 indicates that the process related to the parking space selection is being performed at present, by causing the color of the text label "parking space selection" to be different from the color of the other two text labels.

[0136] A graphic G14 represents a current date. In an example illustrated in Fig. 12, the graphic G14 indicates that the current date is July 22, 2016.

[0137] A graphic G15 represents information related to the parking lot. In an example illustrated in Fig. 12, the graphic G15 indicates that the name of the parking lot is "****", and the location of the parking lot is "east longitude* north latitude*".

[0138] Fig. 13 illustrates the parking space selection screen GC that is displayed after one of the selectable parking spaces is selected. The parking space selection screen GC illustrated in Fig. 13 is different from the parking space selection screen GC illustrated in Fig. 12 in that a graphic G16 is displayed and that the color of the text label "route selection" is different from the color of other two text labels in graphic G13.

[0139] The graphic G16 represents routes that can be taken when moving the shovel 100 from the current location to the selected parking space. In an example illustrated in Fig. 13, the display device D1 displays graphics G16A and G16B representing two selectable routes. Further, the display device D1 displays the selectable routes in such a way that the operator can distinguish between the selected route and an unselected route, by causing at least one of the color, line type, etc., of the

graphics G16 to vary. Specifically, the display device D1 indicates that the route represented by the graphic G16A (solid line) is selected by the operator. It is possible for the operator to select a desired route by touching a portion corresponding to the desired route on the touch panel attached to the display device D1.

[0140] Further, in an example illustrated in Fig. 13, the display device D1 indicates that the process related to the route selection is being performed at present, by causing the color of the text label "route selection" to be different from the color of the other two text labels.

[0141] After one of the plurality of selectable routes is selected, the controller 30 starts the autonomous traveling of the shovel 100. During the autonomous traveling of the shovel 100, the display device D1 may display a screen indicating that the graphic G10 representing the shovel 100 moves along the graphic G16A representing the selected route. At this time, the display device D1 indicates that the autonomous traveling of the shovel 100 is being performed at present, by causing the color of the text label "start traveling" to be different from the color of the other two text labels.

[0142] Next, referring to Fig. 14, another configuration example of the controller 30 will be described. Fig. 14 is a functional block diagram illustrating another configuration example of the controller 30. In an example of Fig. 14, the controller 30 is configured to: receive a signal output by at least one of the posture detection device, the space recognition device 71, the information input device 72, the positioning device 73, an error (abnormality) detection sensor 74, etc.; to perform various calculations; and to output a control command to the proportional valve 31, etc. The posture detection device includes the boom angle sensor S1, the arm angle sensor S2, the bucket angle sensor S3, the device body inclination sensor S4, and the swing angular velocity sensor S5.

[0143] The controller 30 illustrated in Fig. 14 is different from the controller 30 illustrated in Fig. 6 mainly in that the controller 30 is connected to the error detection sensor 74, and that the controller 30 includes a target setting unit F1, an error (abnormality) monitoring unit F2, a stop determination unit F3, an intermediate target setting unit F4, a location calculation unit F5, an object detection unit F6, a velocity command generation unit F7, a velocity calculation unit F8, a velocity control (limiting) unit F9, and a flow rate command generation unit F10. Therefore, in the following, descriptions for common parts will be omitted, and different parts will be described in detail.

[0144] The posture detection unit 30A is configured to detect information related to the posture of the shovel 100 in the same way as the posture detection unit 30A illustrated in Fig. 6. In an example of Fig. 14, the posture detection unit 30A determines whether the posture of the shovel 100 is a traveling posture. Further, the posture detection unit 30A is configured to allow performing the autonomous traveling of the shovel 100 in the case where it is determined that the posture of the shovel 100 is a traveling posture.

[0145] The target setting unit F1 is configured to set a target related to the autonomous traveling of the shovel 100. In an example of Fig. 14, the target setting unit F1 sets, as targets, a parking space in which the shovel 100 is to be parked, and, a route for reaching the parking space, based on an output of the information input device 72. Specifically, the target setting unit F1 sets, as the target parking space (target point), a parking space selected by the operator using the touch panel (refer to the graphic G12D in Fig. 13), and sets, as the target route, a route selected by the operator of the shovel 100 using the touch panel (refer to the graphic G16A in Fig. 13).

[0146] The error monitoring unit F2 is configured to monitor an error (abnormality) of the shovel 100. In an example of Fig. 14, the error monitoring unit F2 determines degrees of an error of the shovel 100 based on an output of the error detection sensor 74. The error detection sensor 74 is, for example, at least one of a sensor that detects an error of the engine 11, a sensor that detects an error related to the temperature of the hydraulic oil, etc.

[0147] The stop determination unit F3 is configured to determine whether it is necessary to stop the shovel 100 based on various information items. In an example of Fig. 14, the stop determination unit F3 determines whether it is necessary to stop the shovel 100 that is traveling autonomously based on an output of the error monitoring unit F2. Specifically, the stop determination unit F3 determines that it is necessary to stop the shovel 100 that is traveling autonomously in the case where the degree of an error of the shovel 100, determined by the error monitoring unit F2, exceeds a predetermined degree. On the other hand, in the case where the degree of an error of the shovel 100 determined by the error monitoring unit F2 is equal to or less than the predetermined degree, the stop determination unit F3 determines that it is not necessary to stop the shovel 100 that is traveling autonomously, in other words, it is possible for the shovel 100 to continue to perform the autonomous traveling.

[0148] The intermediate target setting unit F4 is configured to set an intermediate target related to the autonomous traveling of the shovel 100. In an example of Fig. 14, in the case where it is determined by the posture detection unit 30A that the posture of the shovel 100 is a traveling posture and where it is determined by the stop determination unit F3 that it is not necessary to stop the shovel 100, the intermediate target setting unit F4 divides the target route, which is set by the target setting unit F1, into a plurality of sections, and sets the end point of each section as an intermediate target point.

[0149] The location calculation unit F5 is configured to calculate a current location of the shovel 100. In an example of Fig. 14, the location calculation unit F5 calculates the current location of the shovel 100 based on an output of the positioning device 73.

[0150] A calculation unit F5 is configured to calculate a difference between a location of an intermediate target point set by the intermediate target setting unit F4 and

the current location of the shovel 100 calculated by the location calculation unit F5.

[0151] The object detection unit F6 is configured to detect an object existing around the shovel 100. In an example of Fig. 14, the object detection unit F6 detects an object existing around the shovel 100 based on an output of the space recognition device 70. Further, in the case where an object (e.g., a person) existing in the traveling direction of the shovel 100 that is autonomously traveling, the object detection unit F6 generates a stop command for stopping the autonomous traveling of the shovel 100.

[0152] The velocity command generation unit F7 is configured to generate a command related to the traveling speed. In an example of Fig. 14, the velocity command generation unit F7 generates a velocity command based on the difference calculated by the calculation unit C1. Basically the velocity command generation unit F7 is configured to generate a velocity command that is larger as the difference is larger. Further, the velocity command generation unit F7 is configured to generate a velocity command that causes the difference calculated by the calculation unit C1 to be close to zero.

[0153] The velocity calculation unit F8 is configured to calculate a current traveling speed of the shovel 100. In an example of Fig. 14, the velocity calculation unit F8 calculates the current traveling speed of the shovel 100 based on the transition of the current location of the shovel 100 calculated by the location calculation unit F5.

[0154] A calculation unit C2 is configured to calculate a speed difference between a traveling speed corresponding to the speed command generated by the velocity command generation unit F7 and the current traveling speed of the shovel 100 calculated by the velocity calculation unit F8.

[0155] The velocity control (limiting) unit F9 is configured to limit the traveling speed of the shovel 100. In an example of Fig. 14, the velocity control (limiting) unit F9 is configured to output a limit value instead of the speed difference in a case where the speed difference calculated by the calculation unit C2 exceeds the limit value, and outputs the speed difference as it is in a case where the speed difference calculated by the calculation unit C2 is equal to or less than the limit value. The limit value may be a pre-registered value, or may be a dynamically calculated value.

[0156] The flow rate command generation unit F10 is configured to generate a command related to the flow rate of the hydraulic oil that is supplied from the main pump 14 to the hydraulic traveling motor 2M. In an example of Fig. 14, the flow rate command generation unit F10 generates a flow rate command based on the speed difference output by the velocity control (limiting) unit F9. Basically the flow rate command generation unit F10 is configured to generate a flow rate command that is larger as the speed difference is larger. Further, the flow rate command generation unit F10 is configured to generate a flow rate command that causes the speed difference calculated by the calculation unit C2 to be close to zero.

[0157] The flow rate command generated by the flow rate command generation unit F10 is a current command for each of the proportional valves 31EL, 31ER, 31FL, and 31FR (refer to Fig. 5A and Fig. 5B). The proportional valve 31EL operates in response to the current command, and changes a pilot pressure applied to the left-side pilot port of the control valve 171. Therefore, the flow rate of the hydraulic oil flowing into the left hydraulic traveling motor 2ML is adjusted to become a flow rate corresponding to the flow rate command generated by the flow rate command generation unit F10. The proportional valve 31ER operates in the same way. Further, the proportional valve 31FR operates in response to the current command, and changes a pilot pressure applied to the right-side pilot port of the control valve 172. Therefore, the flow rate of the hydraulic oil flowing into the right hydraulic traveling motor 2MR is adjusted to become a flow rate corresponding to the flow rate command generated by the flow rate command generation unit F10. The proportional valve 31FL operates in the same way. As a result, the traveling speed of the shovel 100 is adjusted to become a traveling speed corresponding to the velocity command generated by the velocity command generation unit F7. It should be noted that the traveling speed of the shovel 100 is a concept including the traveling direction. With respect to the above, the traveling direction of the shovel 100 is determined based on the rotation speed and the rotation direction of the left hydraulic traveling motor 2ML, and the rotation speed and the rotation direction of the right hydraulic traveling motor 2MR.

[0158] According to the above arrangement, it is possible for the controller 30 to realize the autonomous traveling of the shovel 100 from the current location to the target parking space.

[0159] As described above, a shovel 100 according to an embodiment of the present invention includes a lower-part traveling body 1, an upper-part swing body 3 that is turnably mounted on the lower-part traveling body 1, a hydraulic traveling motor 2M as a traveling actuator that drives the lower-part traveling body 1, a space recognition device 70 that is provided in the upper-part swing body 3, an orientation detection device 71 that detects information related to a relative relation between an orientation of the upper-part swing body 3 and an orientation of the lower-part traveling body 1, and a controller 30 as a control device that is provided in the upper-part swing body 3. Further, the controller 30 is configured to cause the hydraulic traveling motor 2M to operate, based on an output of the space recognition device 70 and an output of the orientation detection device 71, and cause the shovel 100 to move to a parking space recognized by the space recognition device 70. According to the above arrangement, it is possible for the shovel 100 to assist the movement of the shovel 100 to the parking location. As a result, the parking of the shovel 100 into the desired parking space can be performed efficiently. Further, it is possible for the shovel 100 to prevent from contacting other object due to the erroneous operation or the like

during parking.

[0160] The shovel 100 includes, for example, an attachment actuator that drives an excavating attachment AT as an attachment attached to the upper-part swing body 3, and a posture detection device that detects the posture of the excavating attachment AT. The attachment actuator includes, for example, a boom cylinder 7, an arm cylinder 8, and a bucket cylinder 9. The posture detection device includes, for example, a boom angle sensor S1, an arm angle sensor S2, and a bucket angle sensor S3. Further, the controller 30 may be configured to cause the attachment actuator to operate based on an output of the space recognition device 70, and may be configured to change the posture of the excavating attachment AT in such a way that the excavating attachment AT does not touch an object recognized by the space recognition device 70. According to the above arrangement, it is possible for the controller 30 to prevent the excavating attachment AT from touching other objects when operating the hydraulic traveling motor 2M to move the shovel 100. The other objects are, an electrical wire, other shovels, vehicles, etc.

[0161] The shovel 100 includes, for example, a hydraulic swing motor 2A as an actuator used for turning the upper-part swing body 3. Further, the controller 30 may be configured to cause the hydraulic swing motor 2A to operate, based on an output of the space recognition device 70 and an output of the orientation detection device 71, and may be configured to cause the upper-part swing body 3 to turn in such a way that the shovel 100 does not touch an object recognized by the space recognition device 70. According to the above arrangement, it is possible for the controller 30 to prevent a counter weight, or the like, from touching other objects when operating the hydraulic traveling motor 2M to move the shovel 100.

[0162] The shovel 100 includes, for example, the information input device 72. The information input device 72 may be configured to allow an operator to input a direction of the parking space viewed from the upper-part swing body 3. Specifically, the information input device 72 may be configured to allow an operator to select the direction of the parking space viewed from the shovel 100 from four directions of front, rear, left, and right. In this case, the space recognition device 70 may be configured to recognize a parking space in a direction selected via the information input device 72. In other words, the controller 30 may omit recognition of parking spaces by the space recognition device 70 in an unselected direction. According to the above arrangement, it is possible for the controller 30 to determine existence/non-existence of parking spaces in a selected direction, quickly and accurately. Further, it is possible for the controller 30 to omit the determination of existence/non-existence of parking spaces in an unselected direction, and to reduce the calculation load.

[0163] The information input device 72 may be, for ex-

ample, configured to allow an operator to input a location of the parking space. Specifically, as illustrated in Fig. 10, the information input device 72 may be configured to allow an operator to select a desired parking space from 27 parking spaces whose longitude, latitude, and altitude are pre-registered. In this case, the space recognition device 70 may be configured to recognize a parking space located at a location selected by using the information input device 72. According to the above arrangement, it is possible for the controller 30 to, after moving the shovel 100 to a parking space located at a relatively farther location from the current location, cause the shovel 100 to be parked in the parking space.

[0164] As described above, one or more preferred embodiments of the present invention are described in detail. However, the present invention is not limited by the above-described embodiments. The above-described embodiments may be modified or replaced appropriately without departing from the scope of the present invention. Further, features described separately may be combined unless there is a technical inconsistency.

[0165] For example, in the above-described embodiment, a hydraulic operation lever with a hydraulic pilot circuit is described. Specifically, in the hydraulic pilot circuit related to the left operation lever 26L as an arm operation lever, the hydraulic oil, which is supplied from the pilot pump 15 to the remote control valve of the left operation lever 26L, is transferred to a pilot port of the control valve 176 with a flow rate corresponding to the opening of the remote control valve that is opened or closed by tilting of the left operation lever 26L.

[0166] It should be noted, however, that an electric operation lever with an electric pilot circuit may be employed instead of the hydraulic operation lever with a hydraulic pilot circuit. In this case, the lever operation amount of the electric operation lever is input to the controller 30 as an electric signal. Further, an electromagnetic valve (solenoid valve) is provided between the pilot pump 15 and a pilot port of each control valve. The electromagnetic valve is configured to operate in response to an electric signal from the controller 30. According to the above arrangement, when a manual operation is performed by using the electric operation lever, it is possible for the controller 30 to move each control valve in the control valve 17 by controlling the electromagnetic valve in response to an electric signal corresponding to the lever operation amount to increase or reduce the pilot pressure. It should be noted that each control valve may be formed by an electromagnetic spool valve (solenoid spool valve). In this case, the electromagnetic valve operates in response to an electric signal, corresponding to the lever operation amount of the electric operation lever, from the controller 30.

[0167] In the case where an electric operation system with an electric operation lever is employed, it is possible for the controller 30 to perform the autonomous control function more easily compared with a case in which a hydraulic operation system with a hydraulic operation lever

is employed. Fig. 15 illustrates a configuration example of an electric operation system. Specifically, the electric operation system illustrated in Fig. 15 is an example of a boom operation system used for raising and lowering the boom 4, and mainly includes a pilot-pressure-operated control valve 17, a boom operation lever 26A as an electric operation lever, a controller 30, an electromagnetic (solenoid) valve 60 for boom raising operation, and an electromagnetic (solenoid) valve 62 for boom lowering operation. The electric operation system illustrated in Fig. 15 can be also applied to a traveling operation system used for moving the lower-part traveling body 1 forward and backward, a swing operation system used for turning the upper-part swing body 3, an arm operation system used for opening and closing the arm 5, a bucket operation system used for opening and closing the bucket 6, etc.

[0168] The pilot-pressure-operated control valve 17 includes a control valve 171 related to the left hydraulic traveling motor 2ML (refer to Fig. 3), a control valve 172 related to the right hydraulic traveling motor 2MR (refer to Fig. 3), a control valve 173 related to the hydraulic swing motor 2A (refer to Fig. 3), a control valve 175 related to the boom cylinder 7 (refer to Fig. 3), a control valve 176 related to the arm cylinder 8 (refer to Fig. 3), and a control valve 174 related to the bucket cylinder 9 (refer to Fig. 3). The electromagnetic valve 60 is configured to adjust a pressure of the hydraulic oil in a line that connects the pilot pump 15 and an up-side pilot port of the control valve 175. The electromagnetic valve 62 is configured to adjust a pressure of the hydraulic oil in a line that connects the pilot pump 15 and a down-side pilot port of the control valve 175.

[0169] When an manual operation is performed, the controller 30 generates a boom-up operation signal (electric signal) or a boom-down operation signal (electric signal), in response to an operation signal output by an operation signal generation unit of the boom operation lever 26A. The operation signal output by the operation signal generation unit of the boom operation lever 26A is an electric signal that varies according to the operation amount and the operation direction of the boom operation lever 26A.

[0170] Specifically, the controller 30 outputs a boom-up operation signal (electric signal), corresponding to the lever operation amount, to the electromagnetic valve 60 in the case where the boom operation lever 26A is operated in the boom-up direction. The electromagnetic valve 60 operates in response to a boom-up operation signal (electrical signal) to control the pilot pressure as a boom-up operation signal (pressure signal) acting on the up-side pilot port of the control valve 175. Similarly, the controller 30 outputs a boom-down operation signal (electric signal), corresponding to the lever operation amount, to the electromagnetic valve 62 in the case where the boom operation lever 26A is operated in the boom-down direction. The electromagnetic valve 62 operates in response to a boom-down operation signal (electric signal) to con-

trol the pilot pressure as a boom-down operation signal (pressure signal) acting on the down-side pilot port of the control valve 175.

[0171] In the case where the autonomous control is performed, the controller 30 generates a boom-up operation signal (electric signal) or a boom-down operation signal (electric signal), in response to a correction operation signal (electric signal), instead of in response to an operation signal (electric signal) output by an operation signal generation unit of the boom operation lever 26A, for example. The correction operation signal may be an electric signal generated by the controller 30, or may be an electric signal generated by a control device, etc., other than the controller 30.

[0172] Information obtained by the shovel 100 may be shared by an administrator and operators of other shovels through a shovel management system SYS illustrated in Fig. 16. Fig. 1 is a schematic diagram illustrating a configuration example of a shovel management system SYS. The management system SYS is a system managing one or more shovels 100. In an embodiment of the present invention, the management system SYS is mainly formed by a shovel 100, an assisting device 200, and a management device 300. Each of the shovel 100, the assisting device 200, and the management device 300 included in the management system SYS may be a single or plural. In an example of Fig. 16, the management system SYS includes a single shovel 100, a single assisting device 200, and a single management device 300.

[0173] The assisting device 200 is typically a mobile terminal device, and is a notebook PC, a tablet PC, a smart phone, etc., carried by a worker or the like at a construction site. The assisting device 200 may be a mobile terminal device carried by an operator of the shovel 100. The assisting device 200 may be a fixed terminal device.

[0174] The management device 300 is typically a fixed terminal device, and is, for example, a server computer provided at a management center etc., outside the construction site. The management device 300 may be a portable computer (for example, a mobile terminal device such as a notebook PC, a tablet PC, a smart phone, etc.,).

[0175] At least one of the assisting device 200 and the management device 300 may include a monitor and an operation device used for the remote operation. In this case, the operator may operate the shovel 100 while using the operation device for the remote operation. The operation device for the remote operation is connected to the controller 30 installed in the shovel 100 via, for example, a radio communication network such as a near field radio communication network, a mobile telecommunication network, or a satellite communication network.

[0176] Further, although the parking space selection screens GA to GC illustrated in Fig. 8, Fig. 10, Fig. 12, and Fig. 13 are typically displayed by the display device D1 installed in the cabin 10, the parking space selection screens GA to GC may be displayed by a display device connected to at least one of the assisting device 200 and

the management device 300. With respect to the above, it becomes possible for a worker using the assisting device 200 or an administrator using the management device 300 to set the target parking space or to set the target route, or the like.

[0177] In the management system SYS for the shovel 100 as described above, the controller 30 of the shovel 100 may transmit, to at least one of the assisting device 200 and the management device 300, information related to at least one of: the time and place when the parking mode button is pushed; the target trajectory that is used when causing the shovel 100 to autonomously move (when performing the autonomous traveling); and the trajectory that is actually drawn by a predetermined part during the autonomous traveling, or the like. With respect to the above, the controller 30 may transmit, to at least one of the assisting device 200 and the management device 300, at least one of an output of the space recognition device 70, an image captured by a monocular camera, etc. The image may be a plurality of images that are captured during the autonomous traveling. Further, the controller 30 may transmit, to at least one of the assisting device 200 and the management device 300, information related to at least one of: data related to movement of the shovel 100 during the autonomous traveling; data related to the posture of the shovel 100; and data related to the posture of the excavating attachment, etc. With respect to the above, it becomes possible for a worker using the assisting device 200 or an administrator using the management device 300 to obtain information related to the shovel 100 during the autonomous traveling.

[0178] As described above, in the management system SYS of the shovel 100 according to an embodiment of the present invention, information related to the shovel 100 obtained during the autonomous traveling can be shared by the administrator and the operators of other shovels.

[0179] Further, although the controller 30 is configured to cause the shovel 100 to be parked at the target parking space, the controller 30 may be configured to move the shovel 100 from the parking space to a desired location.

[0180] The present application is based on and claims priority to Japanese patent application No. 2018-057172 filed on March 23, 2018, the entire contents of which are hereby incorporated herein by reference.

[DESCRIPTION OF THE REFERENCE NUMERALS]

[0181] 1 Lower-part traveling body; 1C Crawler; 1CL Left crawler; 1CR Right crawler; 2 Swing mechanism; 2A Hydraulic swing motor; 2M Hydraulic traveling motor; 2ML Left hydraulic traveling motor; 2MR Right hydraulic traveling motor; 3 Upper-part swing body; 4 Boom; 5 Arm; 6 Bucket; 7 Boom cylinder; 8 Arm cylinder; 9 Bucket cylinder; 10 Cabin; 11 Engine; 13 Regulator; 14 Main pump; 15 Pilot pump; 17 Control valve; 18 Aperture; 19 Control pressure sensor; 26 Operation device; 26A Boom operation lever; 26D Traveling lever; 26DL Left traveling lever;

26DR Right traveling lever; 26L Left operation lever; 26R Right operation lever; 28 Discharge pressure sensor; 29, 29DL, 29DR, 29LA, 29LB, 29RA, 29RB Operation pressure sensor; 30 Controller; 30A Posture detection unit; 30B Determination unit; 30C Autonomous control unit; 31, 31AL-31DL; 31AR-31DR Proportional valve; 32, 32AL-32DL, 32AR-32DR Shuttle valve; 40 Center bypass line; 42 Parallel line; 60, 62 Electromagnetic valve; 70 Space recognition device; 70F Front sensor; 70B Rear sensor; 70L Left side sensor; 70R Right side sensor; 100 Shovel; 71 Orientation detection device; 72 Information input device; 73 Positioning device; 74 Error detection sensor; 171-176 Control valve; 200 Assisting device; 300 Management device; AT Excavating attachment; C1, C2 Calculation unit; D1 Display device; D2 Sound output device; F1 Target setting unit; F2 Error monitoring unit; F3 Stop determination unit; F4 Intermediate target setting unit; F5 Location calculation unit; F6 Object detection unit; F7 Velocity command generation unit; F8 Velocity calculation unit; F9 Velocity limit unit; F10 Flow rate command generation unit; NS Switch; S1 Boom angle sensor; S2 Arm angle sensor; S3 Bucket angle sensor; S4 Device body inclination sensor; S5 Swing angular velocity sensor

Claims

1. A shovel comprising:

a lower-part traveling body;
 an upper-part swing body that is turnably mounted on the lower-part traveling body;
 a traveling actuator that drives the lower-part traveling body;
 a space recognition device that is provided in the upper-part swing body;
 an orientation detection device that detects information related to a relative relation between an orientation of the upper-part swing body and an orientation of the lower-part traveling body; and
 a control device that is provided in the upper-part swing body,
 wherein the control device operates the traveling actuator based on an output of the space recognition device and an output of the orientation detection device.

2. The shovel according to claim 1,
 wherein the control device is configured to move the shovel to an input specified space.

3. The shovel according to claim 1, comprising:

an attachment actuator that drives an attachment attached to the upper-part swing body; and
 a posture detection device that detects a posture

of the attachment,
 wherein the control device is configured to operate the attachment actuator based on an output of the posture detection device and an output of the space recognition device, and to change a posture of the attachment in such a way that the attachment does not touch an object that is recognized by the space recognition device.

4. The shovel according to claim 1, comprising:

A swing actuator that swings the upper-part swing body,
 wherein the control device is configured to operate the swing actuator based on an output of the space recognition device and an output of the orientation detection device, and to cause the upper-part swing body to turn in such a way that the shovel does not touch an object recognized by the space recognition device.

5. The shovel according to claim 1, comprising:

an information input device,
 wherein the information input device is configured to allow an input of a direction of a specified space viewed from the upper-part swing body, and
 the space recognition device is configured to recognize the specified space in the direction input through the information input device.

6. The shovel according to claim 1, comprising:

an information input device,
 wherein the information input device is configured to allow an input of a location of a specified space, and
 the space recognition device is configured to recognize the specified space in the location input through the information input device.

7. The shovel according to claim 1, comprising:

wherein the control device is configured to move the shovel based on arrangement information.

Amended claims under Art. 19.1 PCT

1. A shovel comprising:

a lower-part traveling body;
 an upper-part swing body that is turnably mounted on the lower-part traveling body;
 a traveling actuator that drives the lower-part traveling body;
 a space recognition device that is provided in

- the upper-part swing body;
 an orientation detection device that detects information related to a relative relation between an orientation of the upper-part swing body and an orientation of the lower-part traveling body; and
 a control device that is provided in the upper-part swing body,
 wherein the control device operates the traveling actuator based on an output of the space recognition device and an output of the orientation detection device.
2. The shovel according to claim 1,
 wherein the control device is configured to move the shovel to an input specified space.
3. The shovel according to claim 1, comprising:
 an attachment actuator that drives an attachment attached to the upper-part swing body; and
 a posture detection device that detects a posture of the attachment,
 wherein the control device is configured to operate the attachment actuator based on an output of the posture detection device and an output of the space recognition device, and to change a posture of the attachment in such a way that the attachment does not touch an object that is recognized by the space recognition device.
4. The shovel according to claim 1, comprising:
 A swing actuator that swings the upper-part swing body,
 wherein the control device is configured to operate the swing actuator based on an output of the space recognition device and an output of the orientation detection device, and to cause the upper-part swing body to turn in such a way that the shovel does not touch an object recognized by the space recognition device.
5. The shovel according to claim 1, comprising:
 an information input device,
 wherein the information input device is configured to allow an input of a direction of a specified space viewed from the upper-part swing body, and
 the space recognition device is configured to recognize the specified space in the direction input through the information input device.
6. The shovel according to claim 1, comprising:
 an information input device,
 wherein the information input device is configured to allow an input of a location of a specified space, and
 the space recognition device is configured to recognize the specified space in the location input through the information input device.
7. The shovel according to claim 1, comprising:
 wherein the control device is configured to move the shovel based on arrangement information.
8. (Added) The shovel according to claim 1,
 wherein the control device determines whether there exists a space through which a body of the shovel can pass.
9. (Added) The shovel according to claim 1,
 wherein the control device determines how to operate the traveling actuator based on a target trajectory.
10. (Added) The shovel according to claim 9,
 wherein the control device controls the traveling actuator and an attachment actuator that drives an attachment based on location information with respect to the target trajectory.
11. (Added) The shovel according to claim 9,
 wherein the control device performs a change of an orientation of a crawler based on the target trajectory by a spin turn.
12. (Added) The shovel according to claim 11,
 wherein the control device performs the spin turn and a swing operation simultaneously.
13. (Added) The shovel according to claim 1,
 wherein the control device sets a parking space as a target.
14. (Added) The shovel according to claim 13,
 wherein the control device sets a target trajectory based on the parking space.
15. (Added) The shovel according to claim 1,
 wherein the control device causes a bucket to touch a ground surface after stopping the traveling actuator of the shovel that has entered a parking space.

FIG. 1

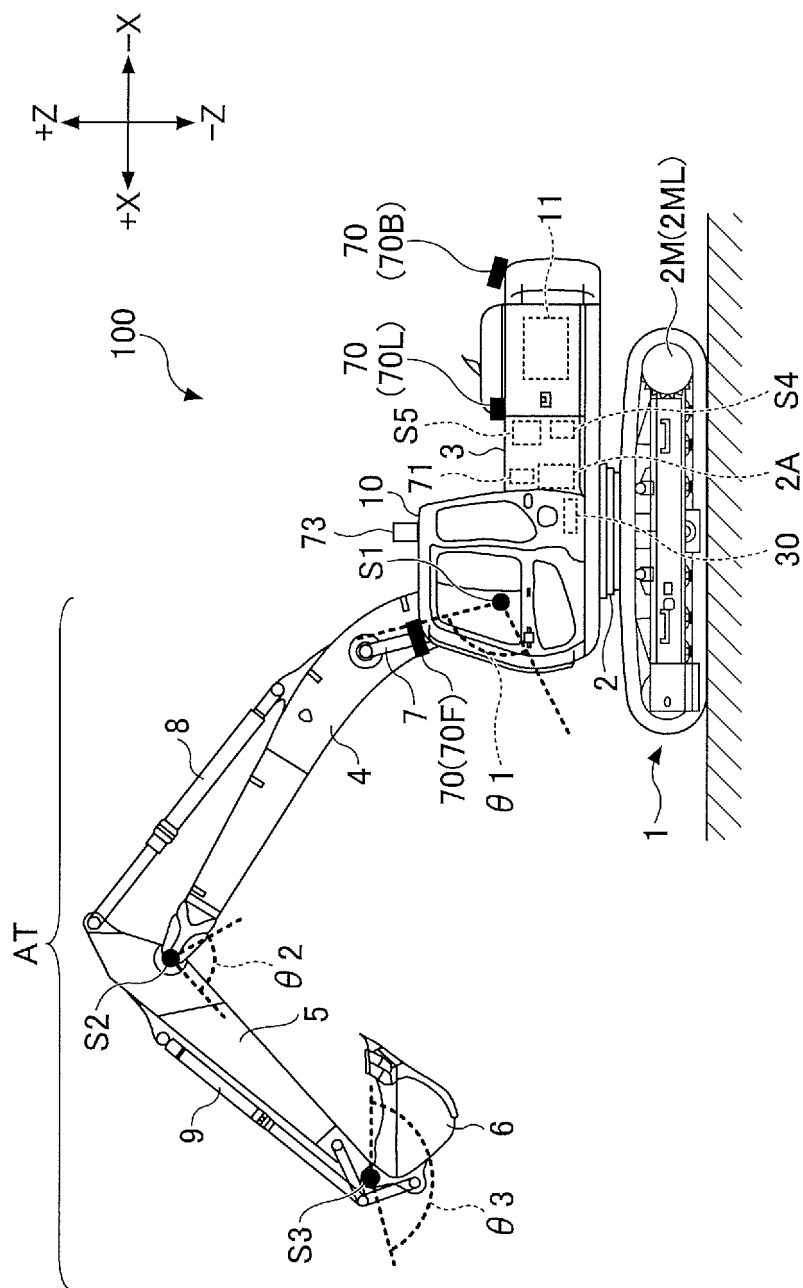


FIG.2

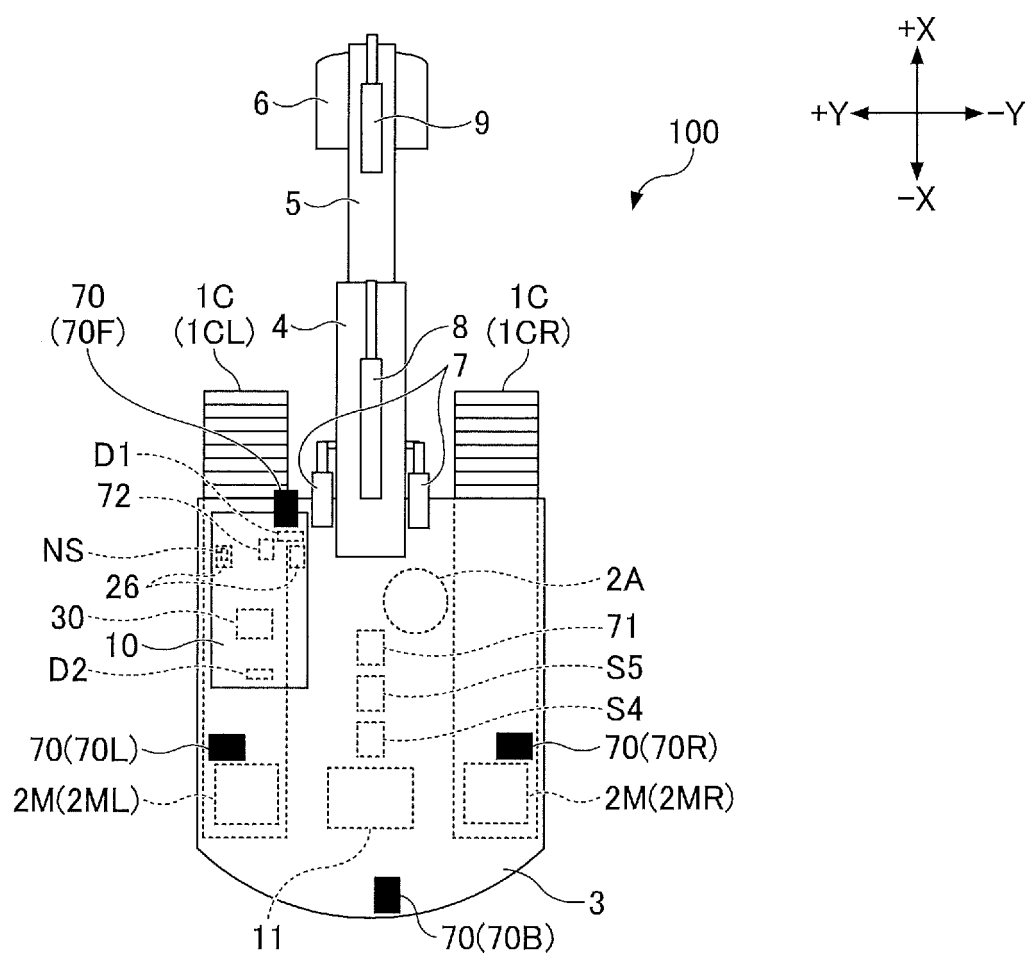


FIG.3

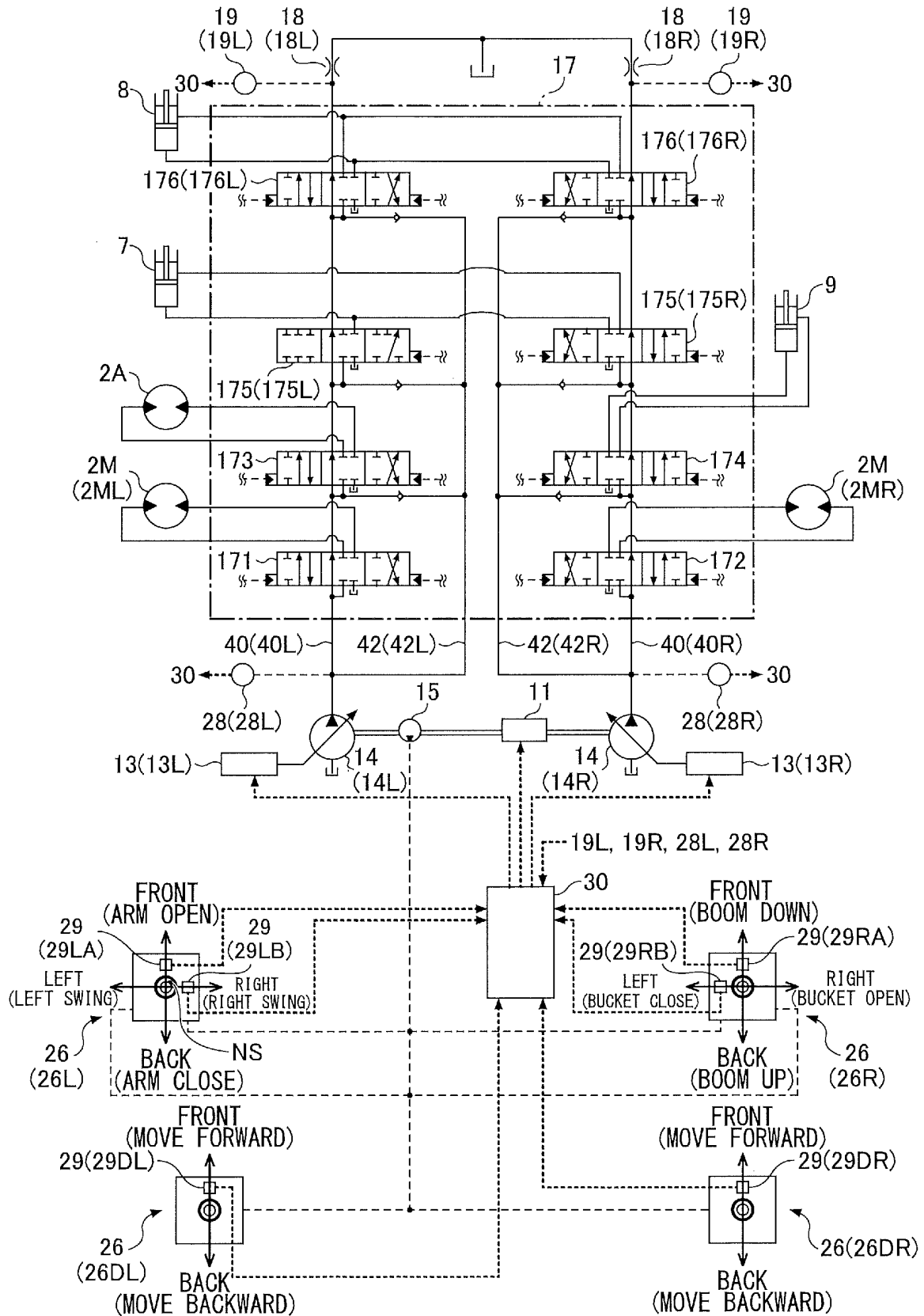


FIG.4A

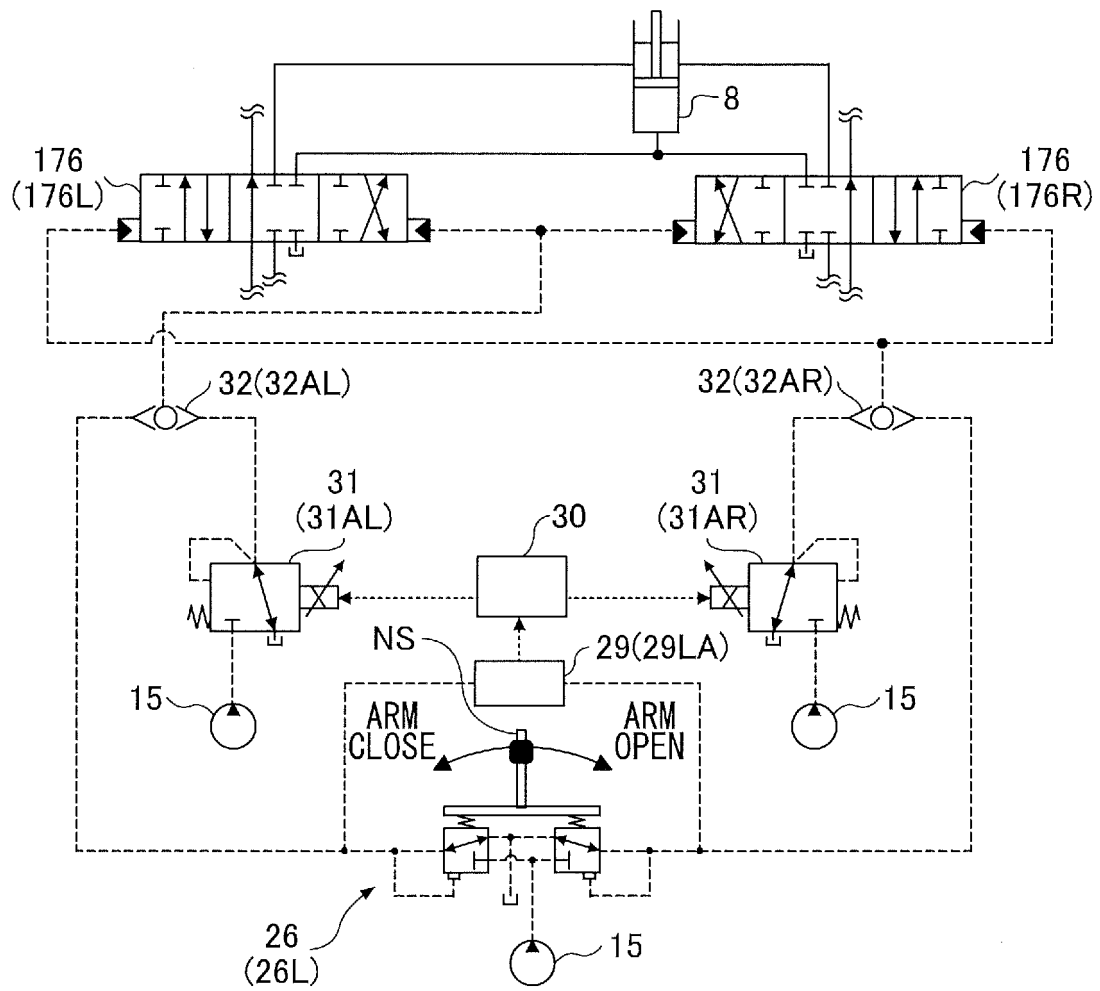


FIG.4B

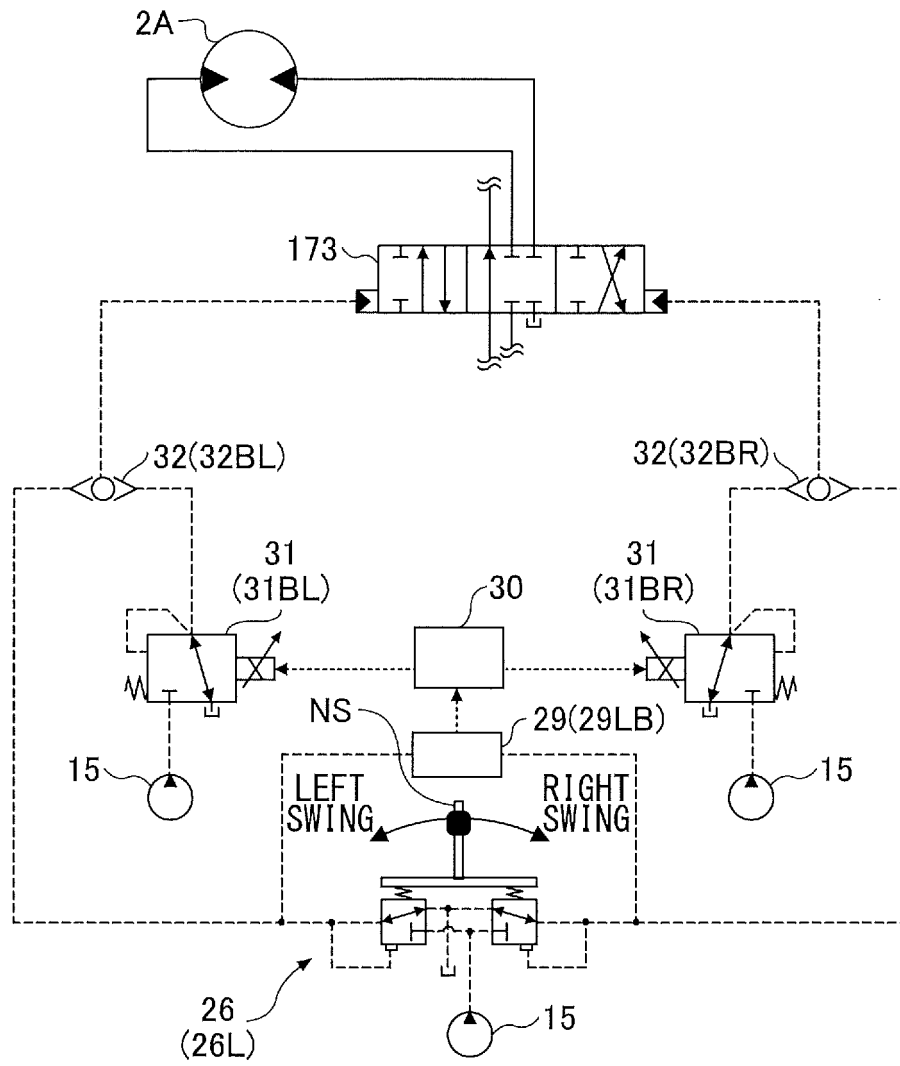


FIG.4C

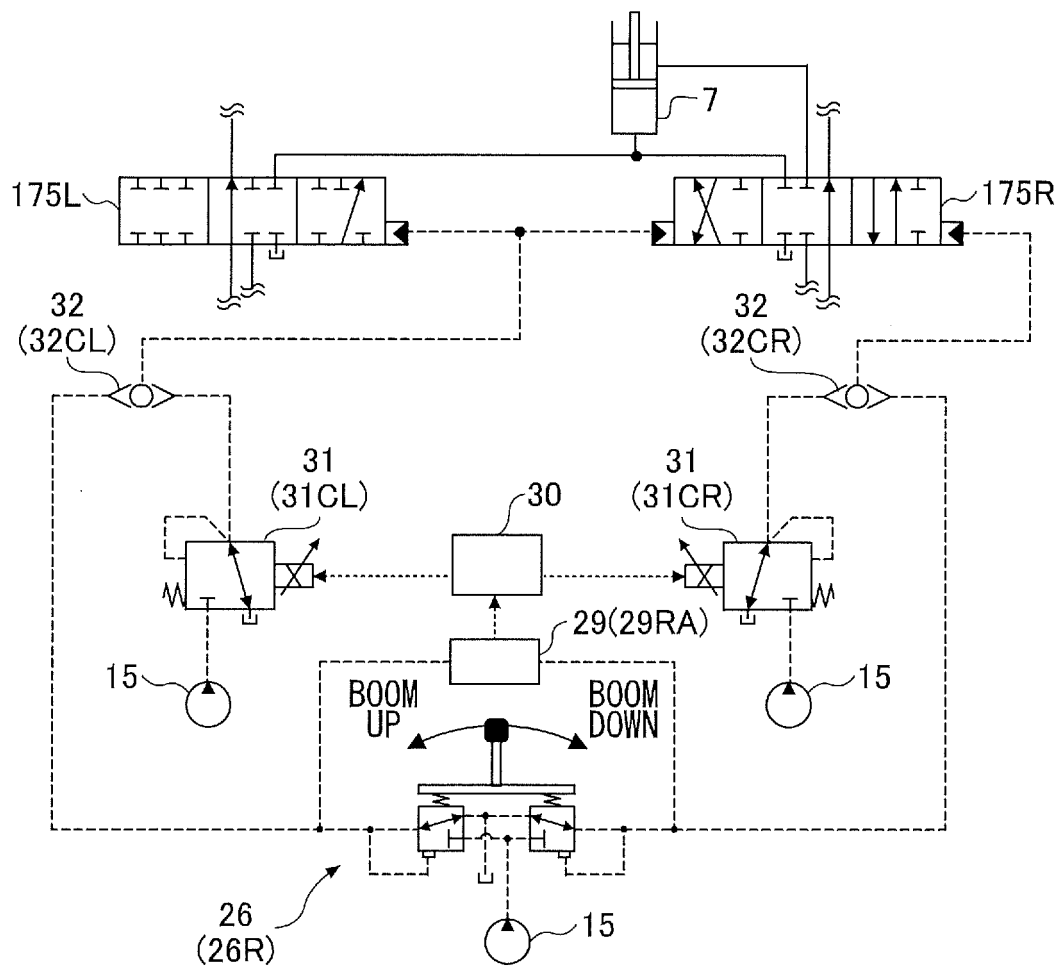


FIG.4D

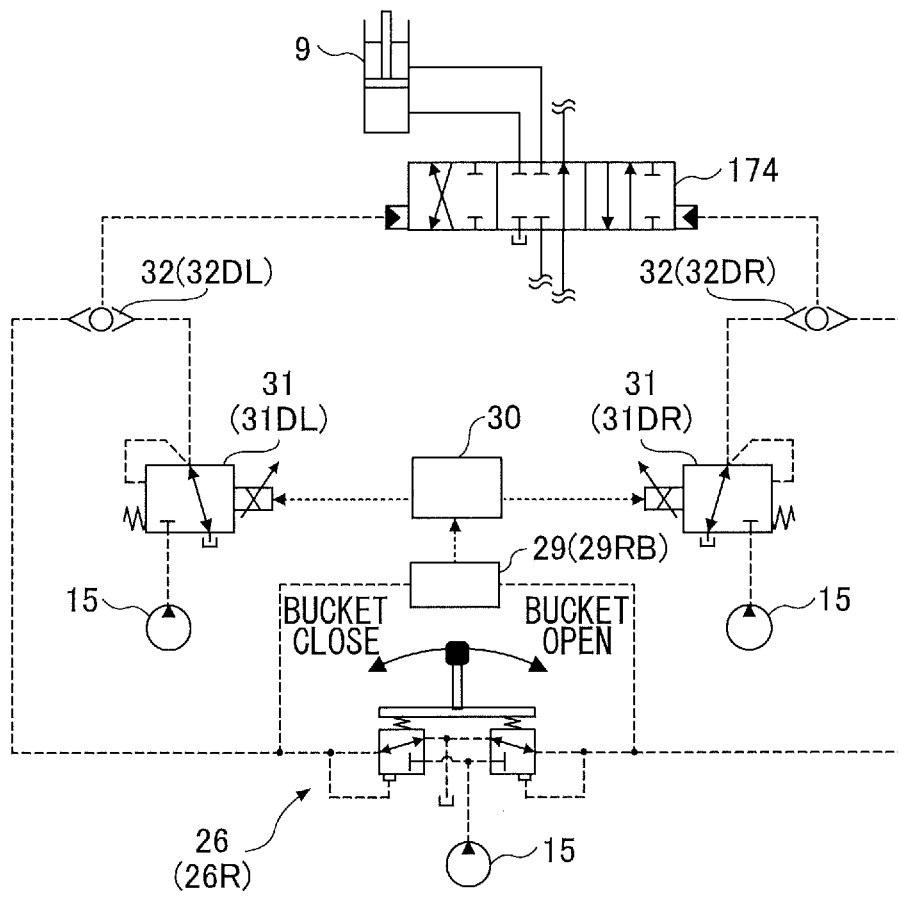


FIG.5A

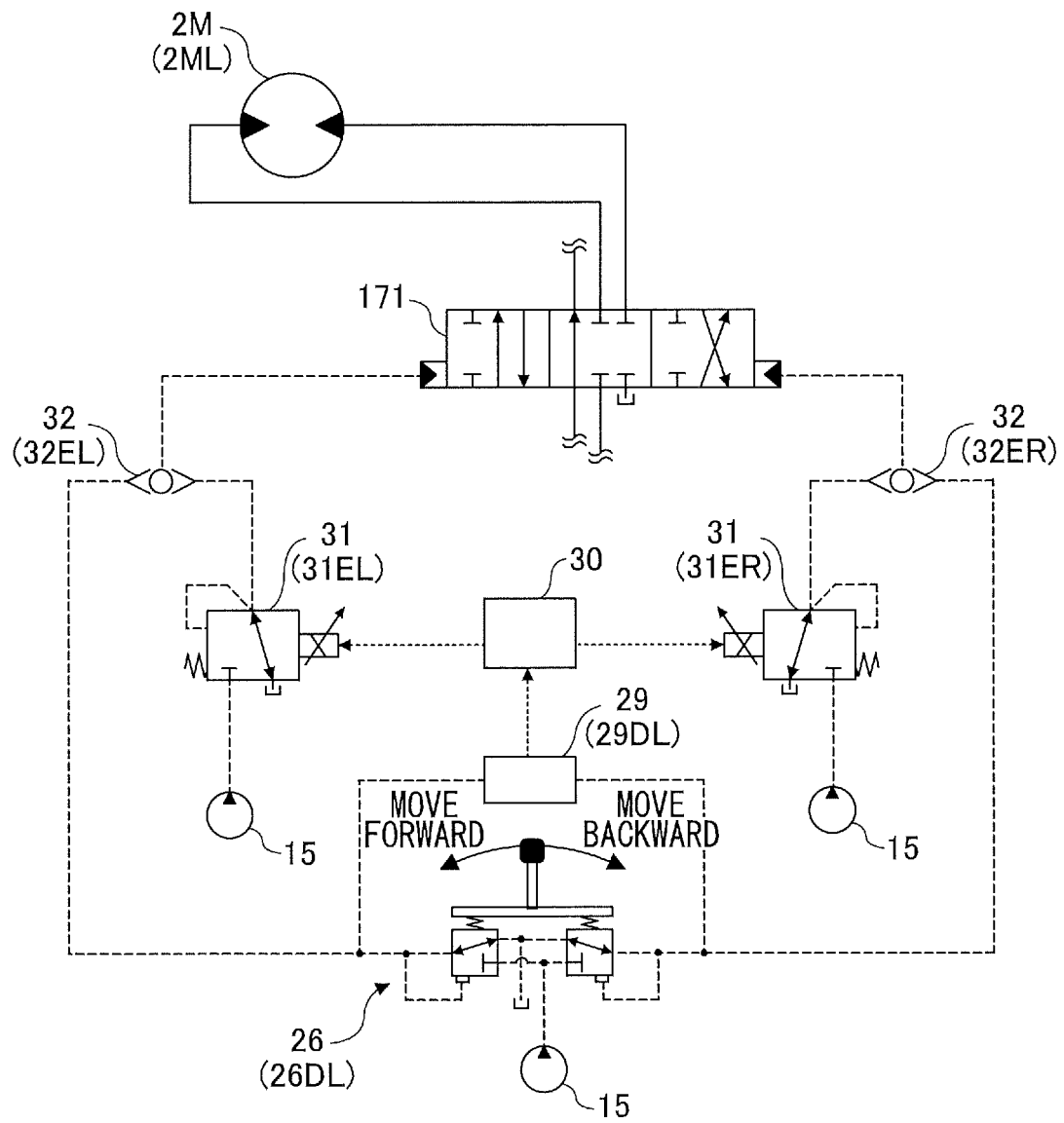
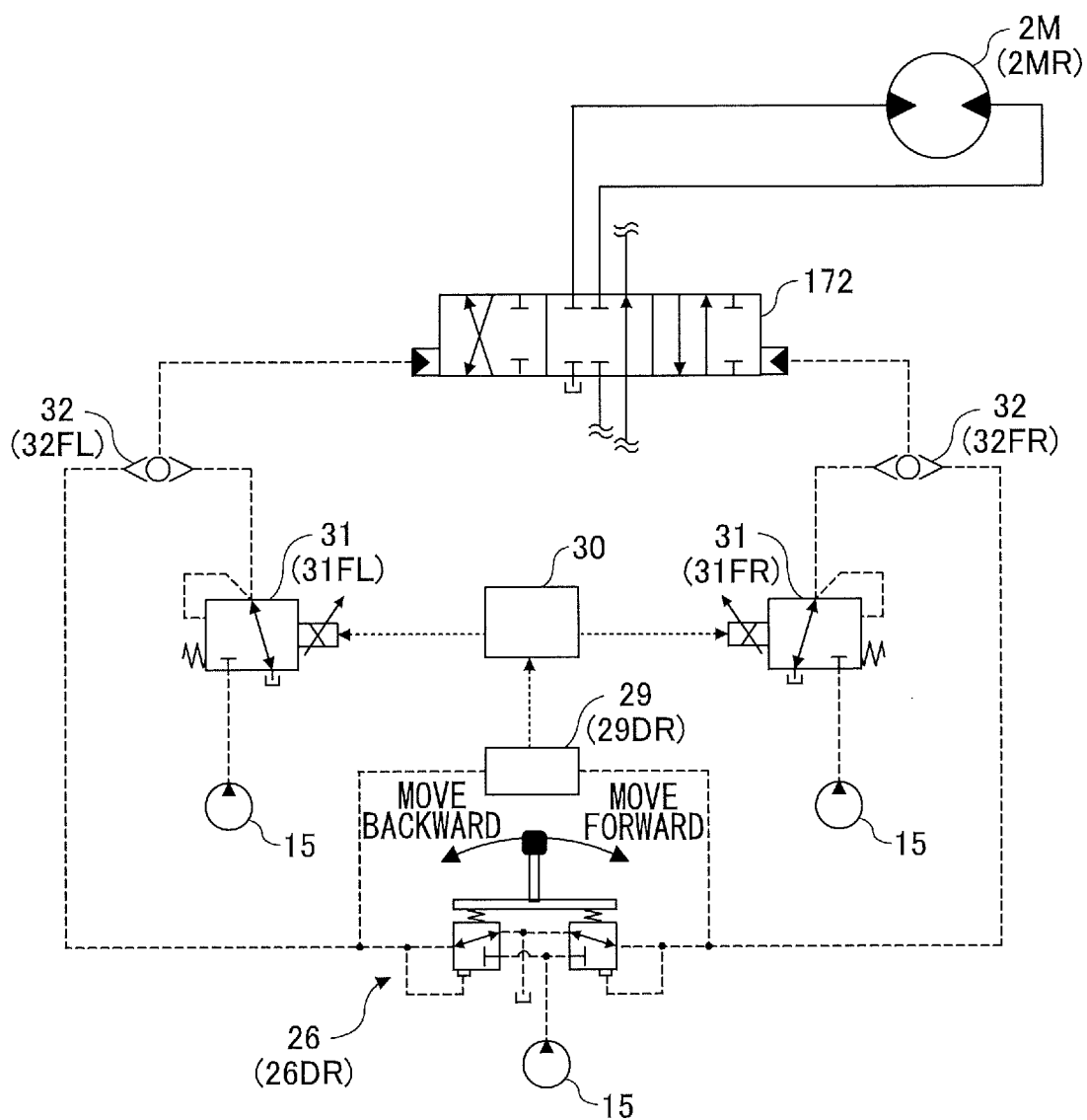


FIG.5B



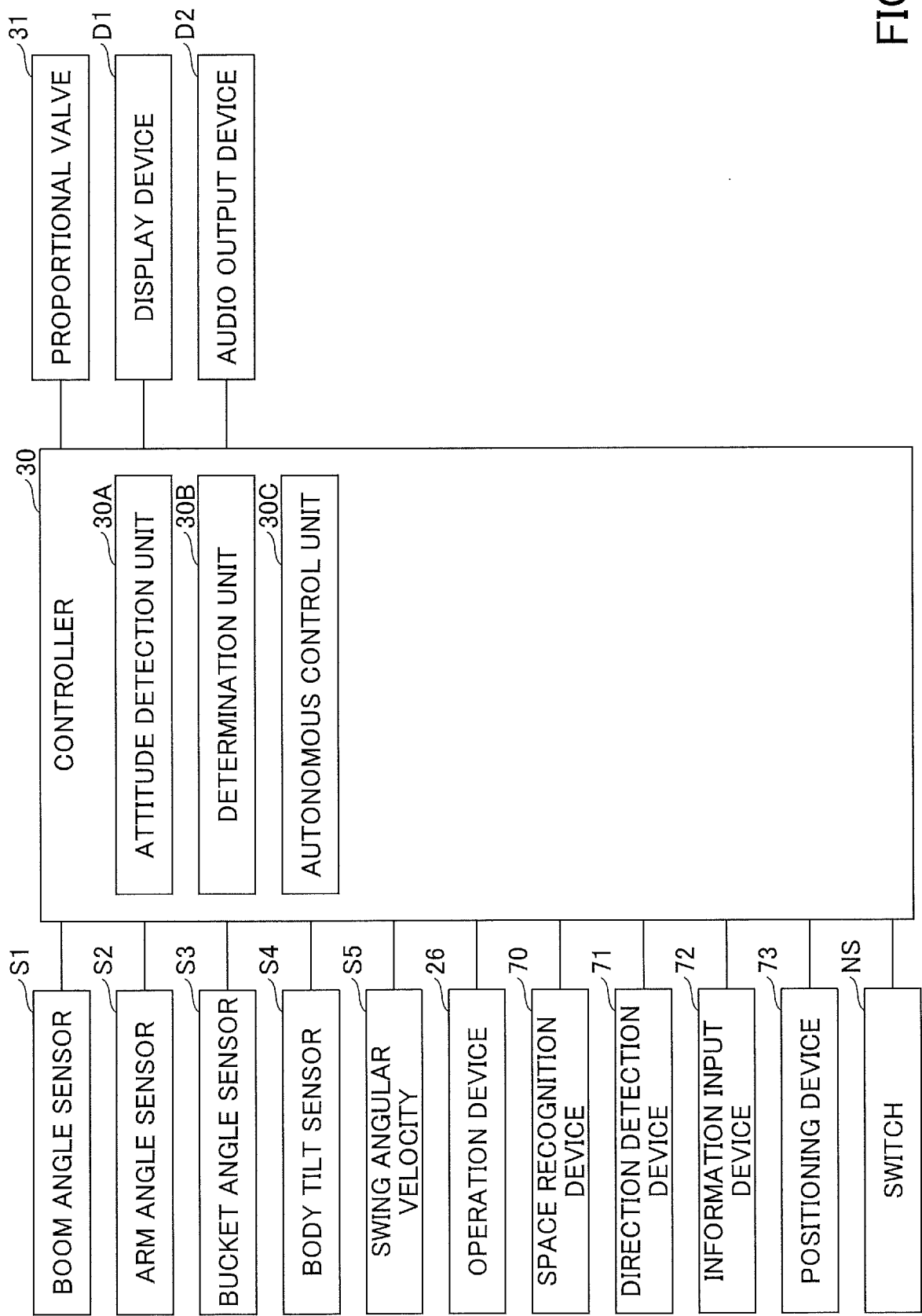


FIG.6

FIG. 7

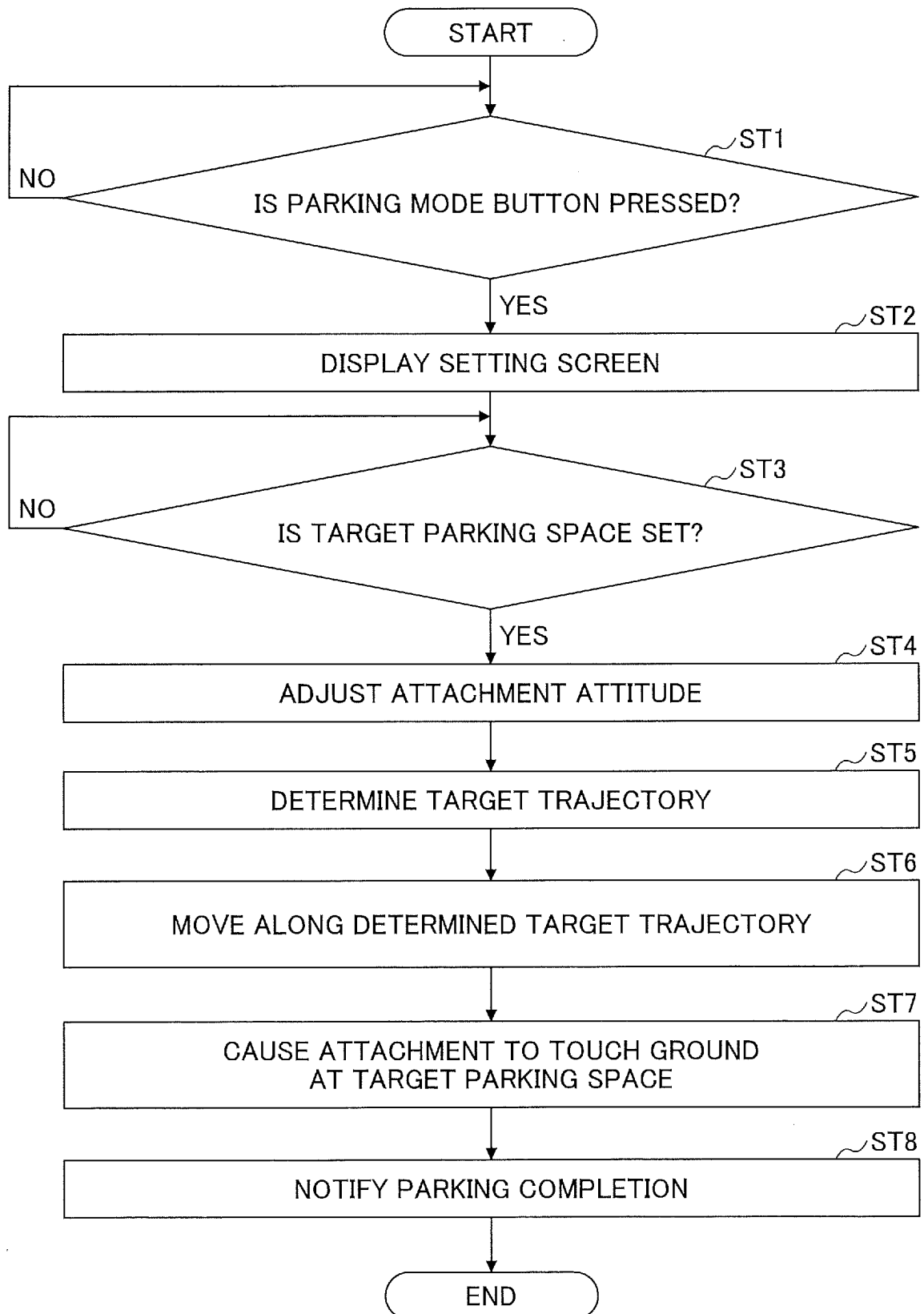


FIG.8

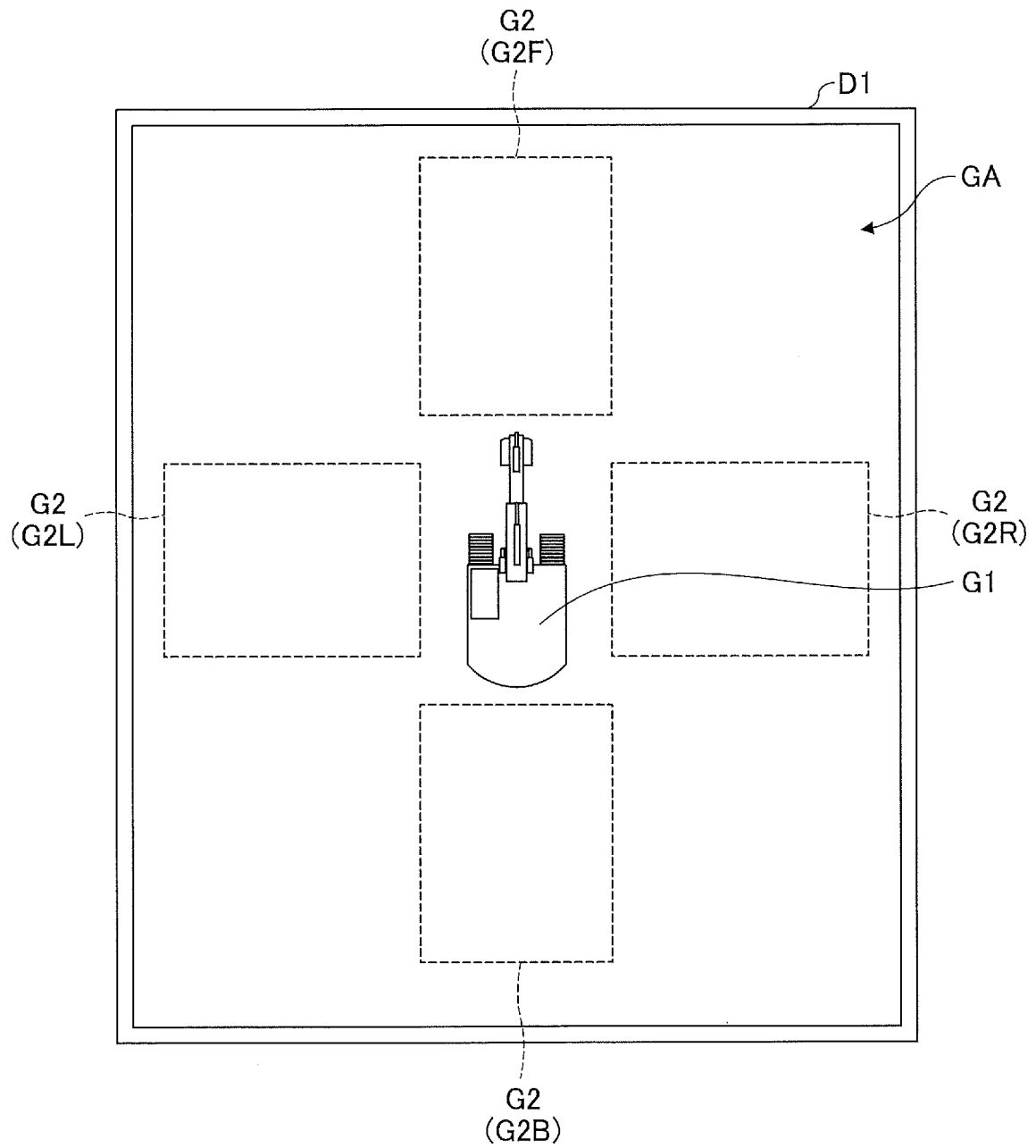


FIG.9

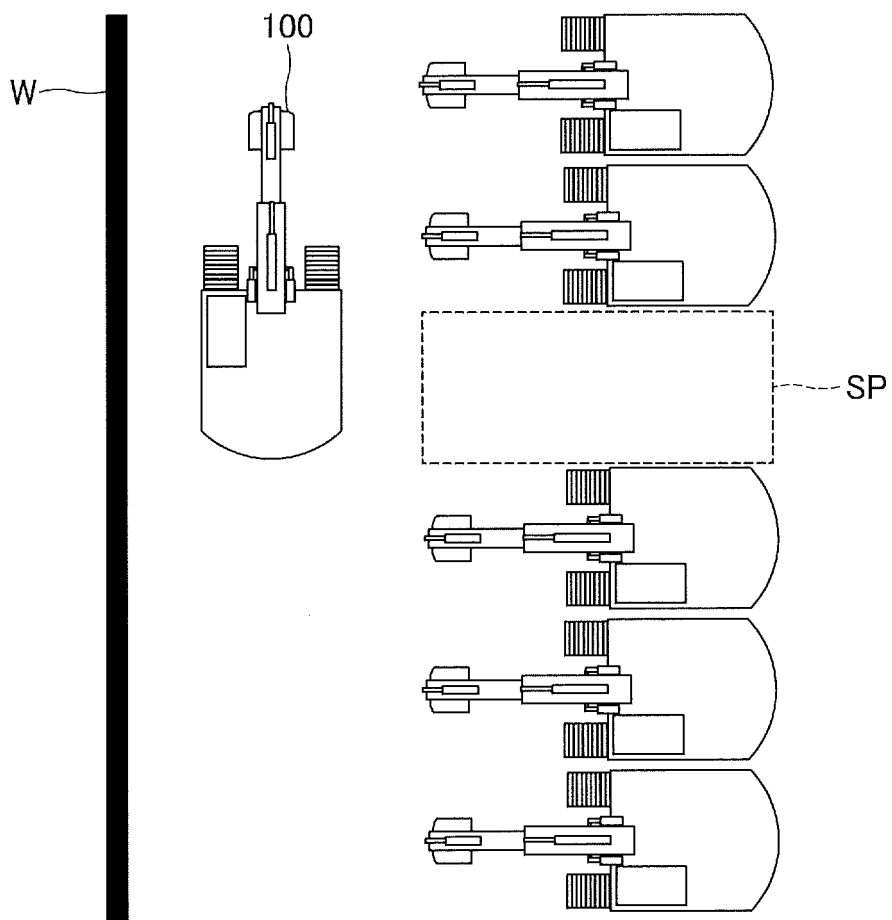


FIG.10

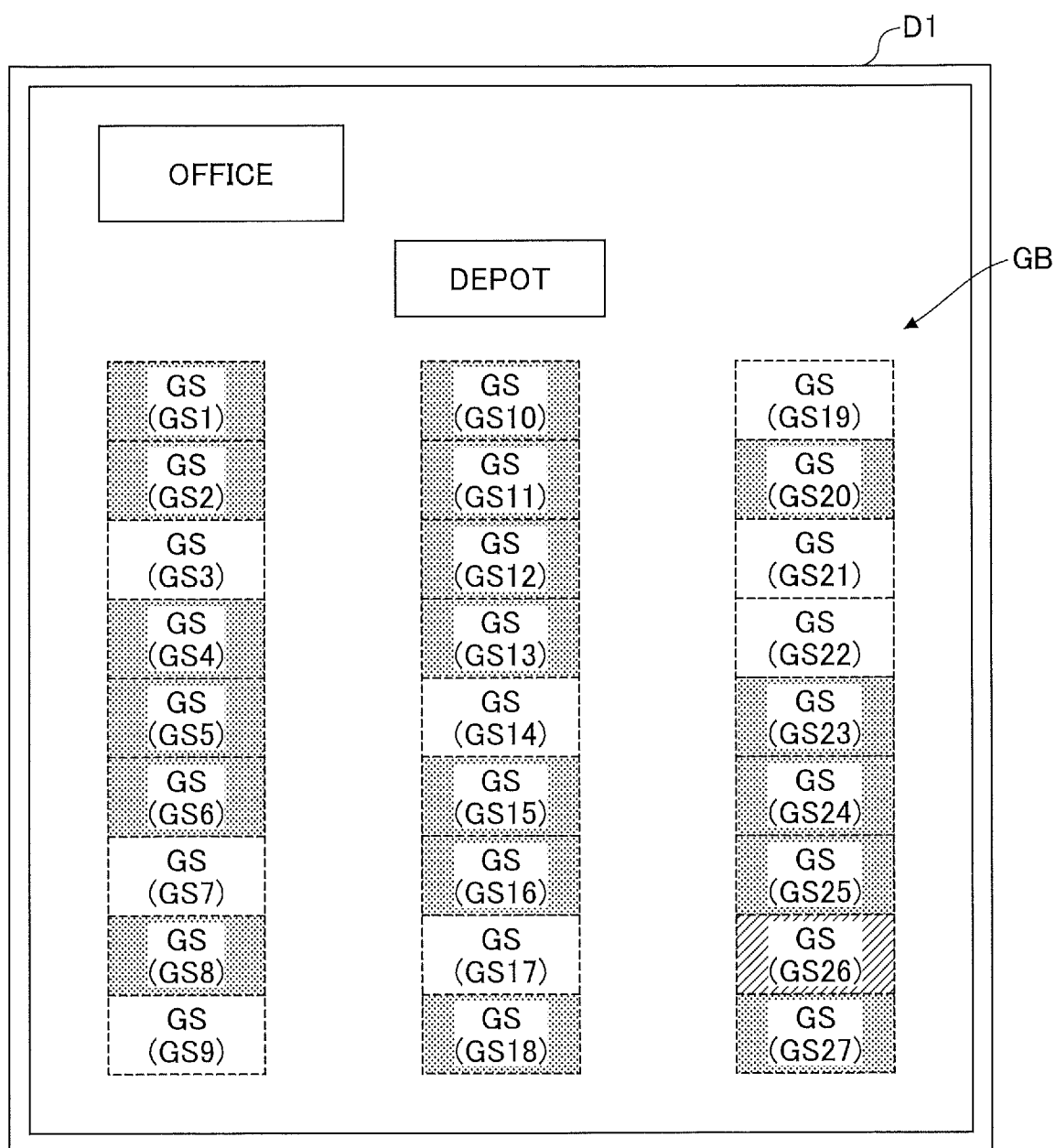


FIG.11

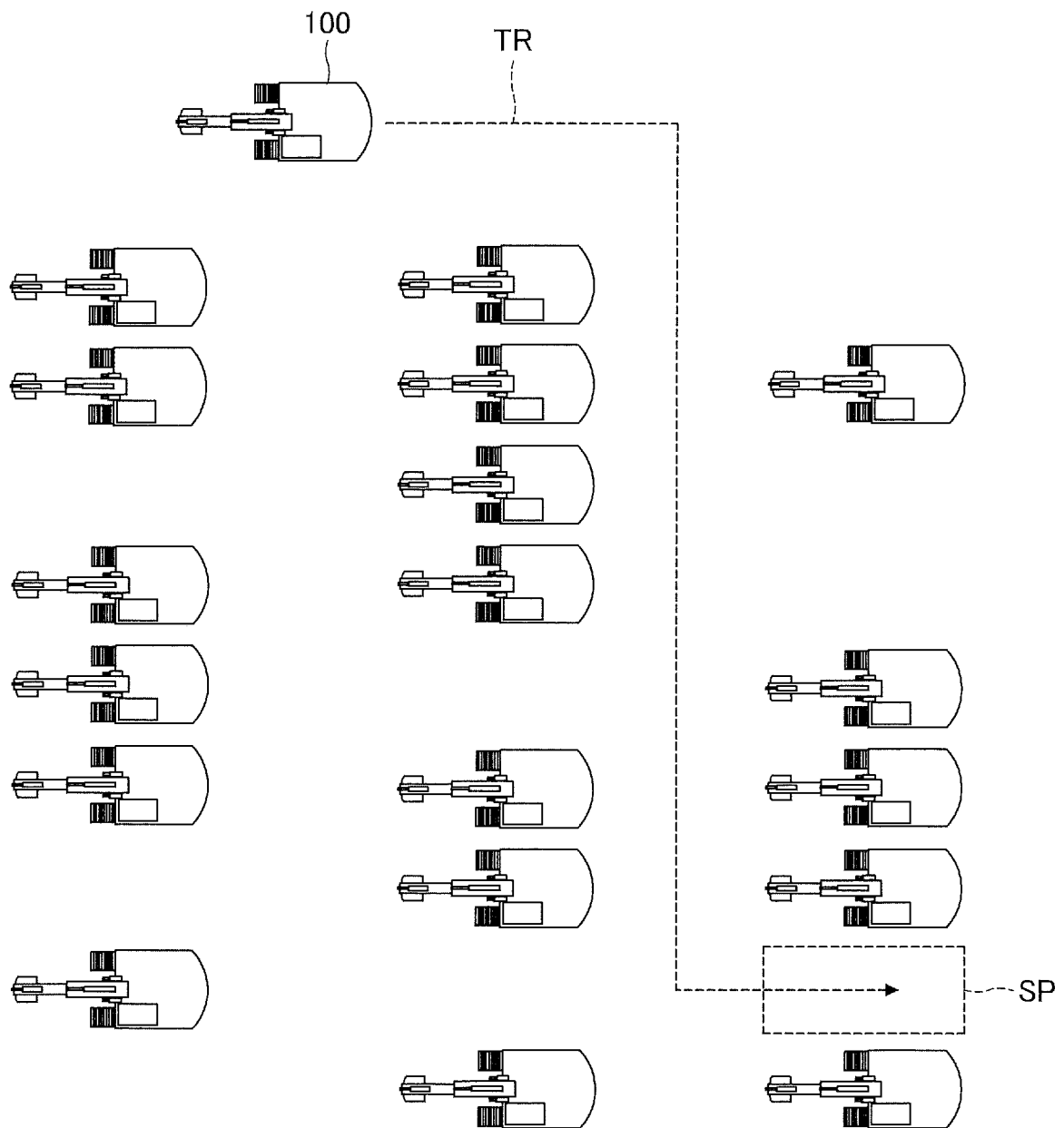


FIG.12

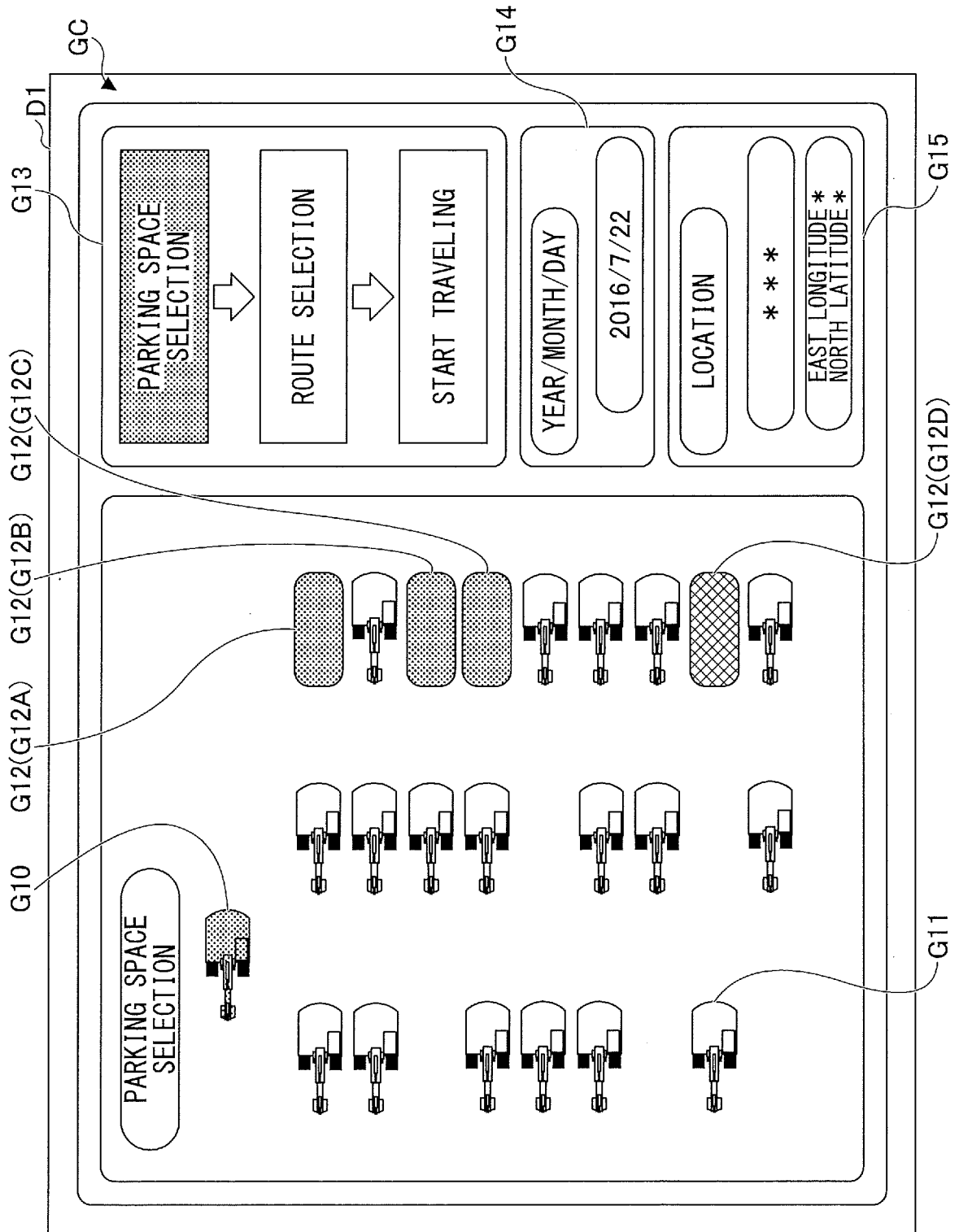


FIG.13

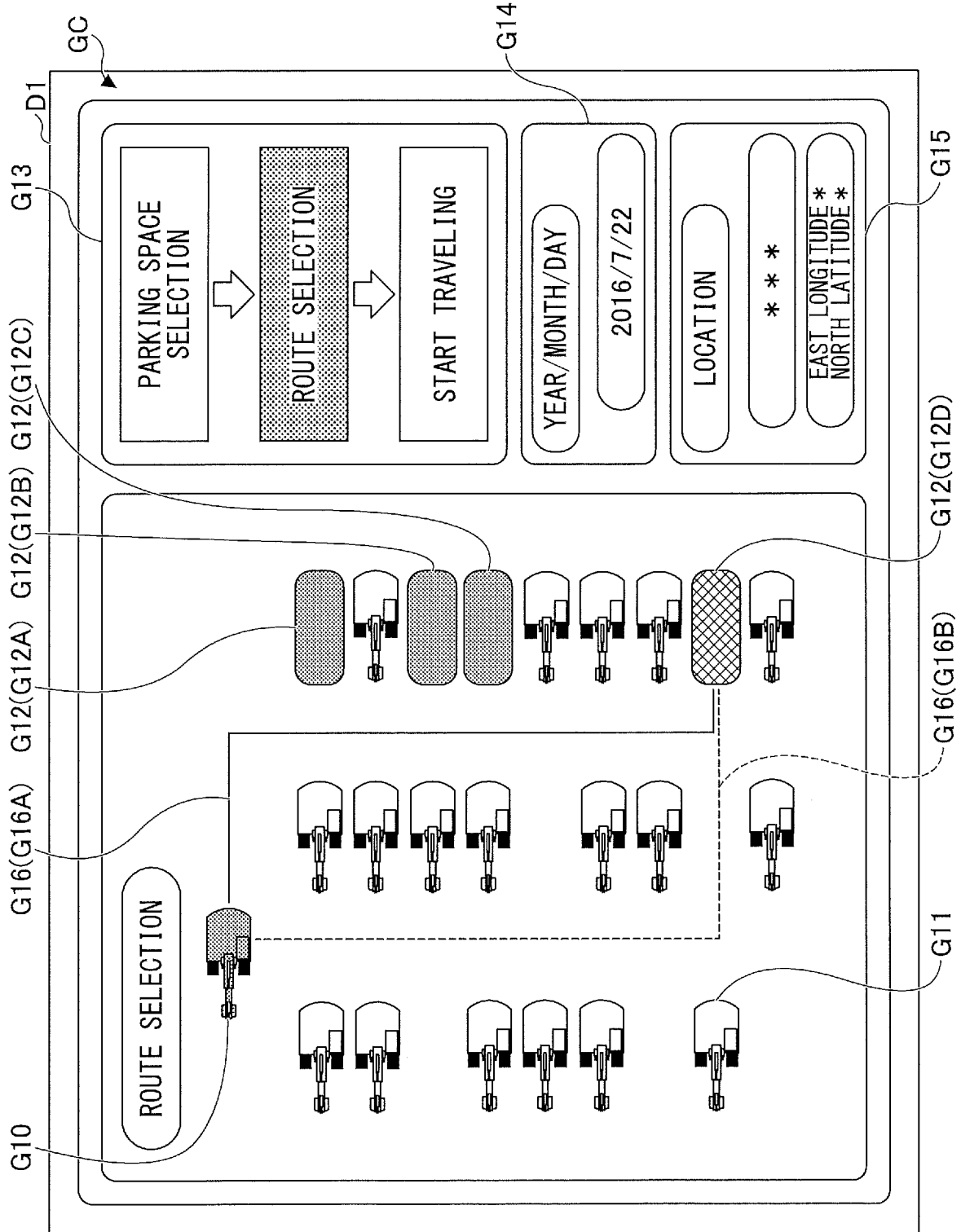
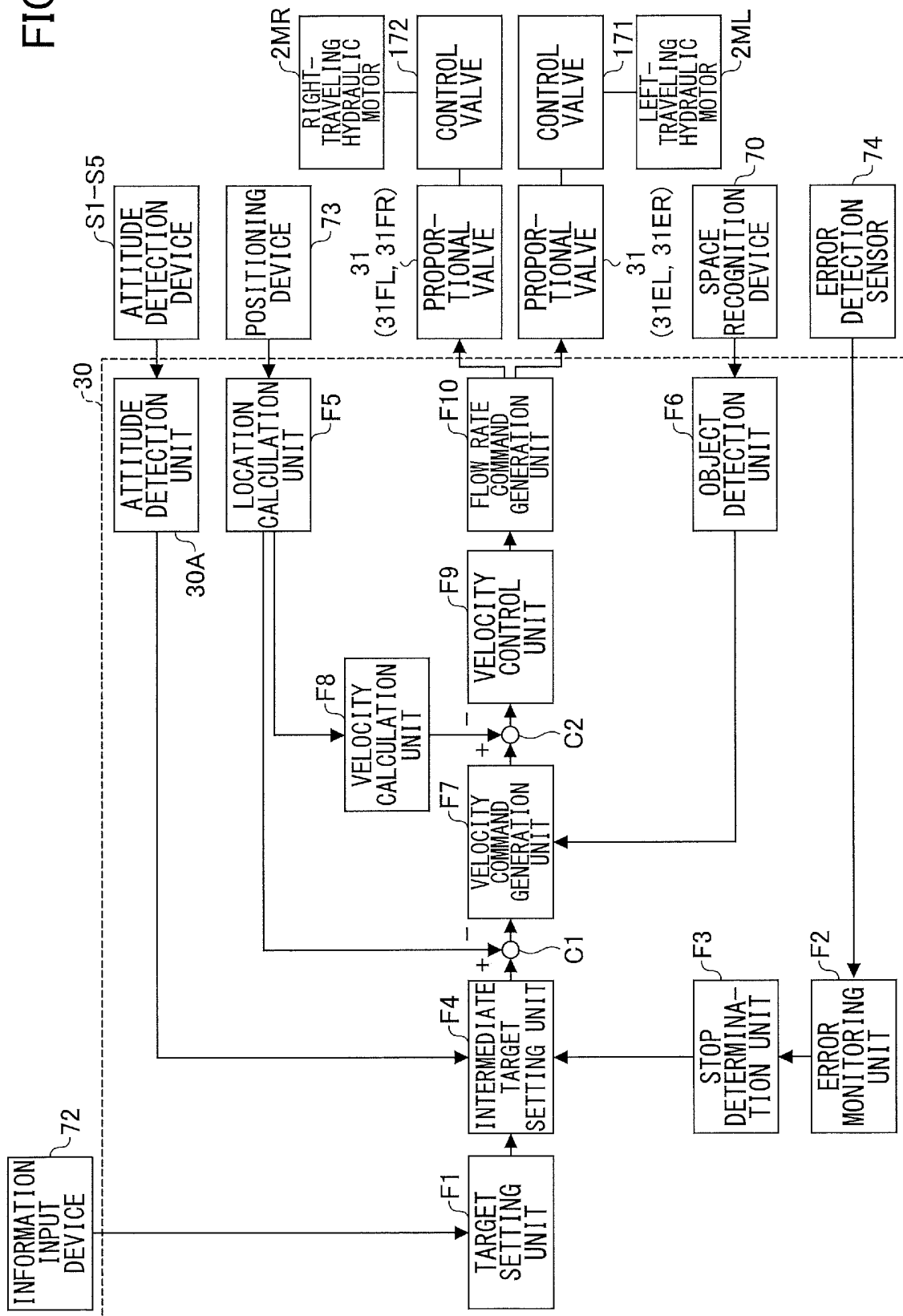
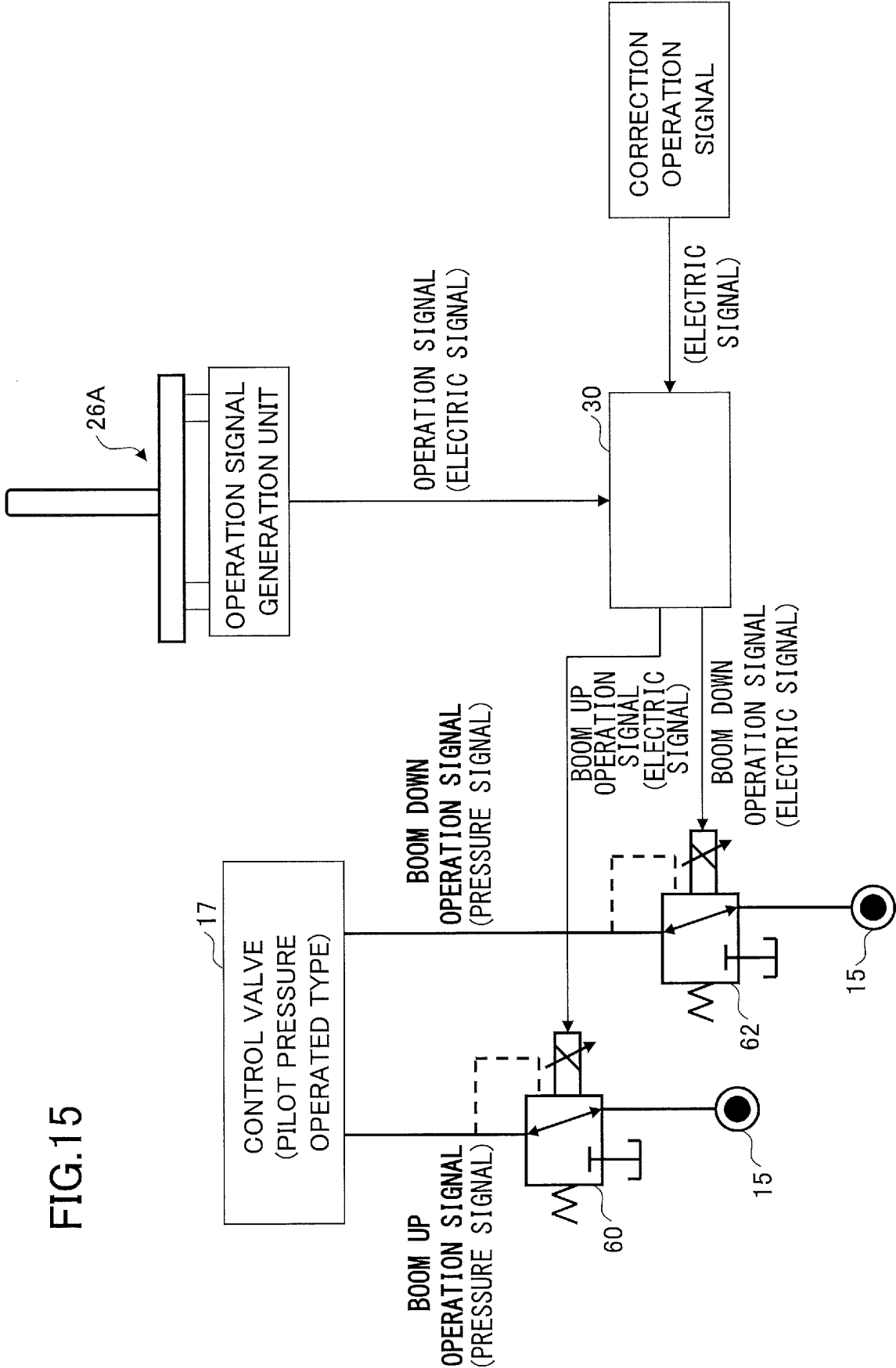
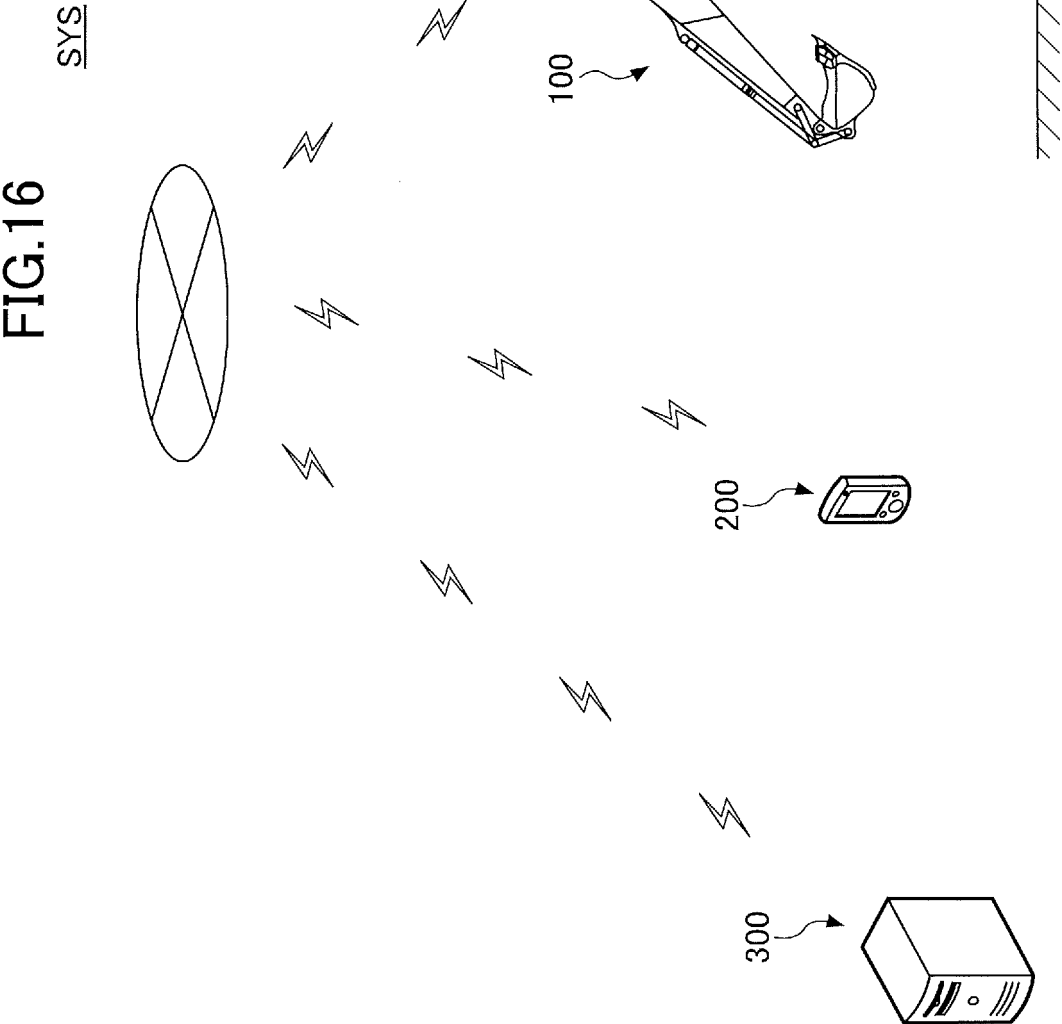


FIG. 14







INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2019/011889

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl. E02F9/20 (2006.01) i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl. E02F9/20-9/26, G05D1/02

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

Published examined utility model applications of Japan 1922-1996

Published unexamined utility model applications of Japan 1971-2019

Registered utility model specifications of Japan 1996-2019

Published registered utility model applications of Japan 1994-2019

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2018-21374 A (KOBELCO CONSTRUCTION MACHINERY CO., LTD.) 08 February 2018, claims, paragraphs [0034]-[0121], fig. 1 & WO 2018/025512 A1 & CN 109563693 A	1
Y		2-7
Y	JP 2002-115272 A (HITACHI CONSTRUCTION MACHINERY CO., LTD.) 19 April 2002, paragraph [0034] (Family: none)	2
Y	JP 2003-261958 A (KOMATSU LTD.) 19 September 2003, claims, paragraph [0019] (Family: none)	3, 7
Y	JP 2016-89559 A (HITACHI CONSTRUCTION MACHINERY CO., LTD.) 23 May 2016, paragraph [0069] (Family: none)	4
Y	JP 11-39035 A (FUJITSU LTD.) 12 February 1999, paragraphs [0005], [0018], fig. 1 (Family: none)	5-6



Further documents are listed in the continuation of Box C.



See patent family annex.

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

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

"&" document member of the same patent family

Date of the actual completion of the international search
10 June 2019 (10.06.2019)

Date of mailing of the international search report
18 June 2019 (18.06.2019)

Name and mailing address of the ISA/
Japan Patent Office
3-4-3, Kasumigaseki, Chiyoda-ku,
Tokyo 100-8915, Japan

Authorized officer

Telephone No.

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Patent documents cited in the description

- JP H8136737 B [0003]
- JP 2018057172 A [0180]