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(54) TRAVELING CONTROL DEVICE FOR WHEELED WORK VEHICLE

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Description

[0001] The disclosure of the following priority application is herein incorporated by reference: Japanese patent application No. 2013-059726 filed March 22, 2013.

[0002] The present invention relates to a traveling control device for a wheeled work vehicle such as a wheeled hydraulic excavator.

[0003] A wheeled hydraulic excavator is an example of a wheeled work vehicle. A wheeled hydraulic excavator includes a wheel type traveling superstructure equipped with four wheels, a revolving superstructure rotatably disposed upon the traveling superstructure and a front work device disposed at a substantially central position on the front side of the revolving superstructure, which includes a boom, an arm and a bucket.

[0004] A traveling motor used to drive the traveling superstructure and hydraulic actuators used to drive the front work device are mounted at the wheeled hydraulic excavator. The flow of pressure oil delivered from a hydraulic pump to the traveling motor is controlled via a traveling directional control valve, whereas the flow of pressure oil delivered from the hydraulic pump to the hydraulic actuators for the front work device is controlled by a work directional control valve.

[0005] Japanese Laid Open Patent Publication No. 2002-130003 discloses a wheel-type work vehicle in which the traveling directional control valve and the work directional control valve, both disposed on a center bypass line, are connected in parallel to the hydraulic pump.

[0006] EP 1 972 726 A1 describes a hydraulic circuit for a wheel type heavy equipment. The hydraulic circuit includes first and second hydraulic pumps, a boom cylinder, an arm cylinder, a boom confluence logic valve, a first port formed to connect with a large chamber of the boom cylinder in a housing in which a spool for the boom cylinder is shiftably installed, a second port to connect with a hydraulic tank in the housing, and a first orifice formed between the housing and a land part of the spool for the boom cylinder located between the first board and the second board.

[0007] US 5,673, 558 A describes a hydraulic circuit system for a hydraulic excavator. In a first valve group of a hydraulic valve apparatus, a variable throttle valve is installed in a feeder passage of the bucket directional control valve downstream of a load check valve, and a secondary pressure as a boom-up operation command is introduced through a line to a pilot control sector of the variable throttle valve which sector operates in the throttling direction. When the secondary pressure is zero or small, the variable throttle valve is fully opened and, as the secondary pressure increases, an opening area of the variable throttle valve is reduced.

[0008] The drive pressure for the traveling motor (hereafter referred to as "traveling drive pressure") in a wheeled hydraulic excavator is lower than the drive pressures for the hydraulic actuators functioning as work operation drive sources. In particular, it is lower than the

drive pressure for the boom cylinder. Thus, if the boom is raised while the wheeled hydraulic excavator, with the traveling directional control valve and the work directional control valve thereof disposed on the center bypass line and connected in parallel to the hydraulic pump, is crawling (i.e., traveling at very low speed) or traveling at low speed, with a relatively low traveling drive pressure, the output pressure at the hydraulic pump will be applied to the lower pressure-side traveling motor rather than to the high pressure-side boom cylinder. As a result, the quantity of pressure oil flowing into the traveling motor will increase sharply, i.e., the traveling speed will rise abruptly, causing the wheeled hydraulic excavator to jerk or surge (hereafter referred to as "bucking"). Such bucking is bound to be an unpleasant experience for the operator riding in the work vehicle crawling or traveling at low speed.

[0009] The above-described problems are overcome by the invention according to claim 1. Further preferred developments are described by the dependent claims.

[0010] A traveling control device for a wheeled work vehicle according to a first aspect of the present invention comprises: a hydraulic pump driven by an engine; a traveling motor driven with pressure oil output from the hydraulic pump; a work device actuator that is driven with pressure oil from the hydraulic pump and drives a front work device; a traveling directional control valve via which a flow of pressure oil from the hydraulic pump to the traveling motor is controlled, and a work device directional control valve via which a flow of pressure oil from the hydraulic pump to the work device actuator is controlled, with the traveling directional control valve and the work device directional control valve disposed on a center bypass line at the hydraulic pump; a flow control valve disposed on an upstream side of the traveling directional control valve, that controls a flow rate of the pressure oil from the hydraulic pump to the traveling motor; a traveling operation member operated to engage the traveling motor in operation; a work operation member operated to engage the work device actuator in operation; a traveling operation quantity detection means for detecting a traveling operation quantity representing an extent of operation of the traveling operation member; a work operation quantity detection means for detecting a work operation quantity representing an extent of operation of the work operation member; an output pressure detection means for detecting an output pressure of the hydraulic pump; and/or a valve control means for controlling the flow control valve in correspondence to the traveling operation quantity detected by the traveling operation quantity detection means, the work operation quantity detected by the work operation quantity detection means and the output pressure of the hydraulic pump detected by the output pressure detection means, wherein: the valve control means controls the flow rate of pressure oil delivered to the traveling motor so as to deter bucking of the wheeled work vehicle if the wheeled work vehicle, currently in a traveling operation-only state in

which the traveling operation member is operated but the work operation member is not operated, shifts into a combination operation state in which the traveling operation member is operated and the work operation member is also operated.

[0011] According to a second aspect of the present invention, the traveling control device for a wheeled work vehicle according to the first aspect may further comprise: a motor pressure detection means for detecting a pressure of pressure oil delivered to the traveling motor, wherein: the valve control means controls the flow control valve by factoring in the pressure detected by the motor pressure detection means.

[0012] Further, according to the first aspect of the present invention, the valve control means deters the bucking of the wheeled work vehicle when shifting from the traveling operation-only state into the combination operation state by controlling the flow control valve so as to achieve a smaller opening area at the flow control valve than the opening area achieved at the flow control valve in the traveling operation-only state.

[0013] According to a third aspect of the present invention, the traveling control device for a wheeled work vehicle according to any one of the first to third aspects may further comprise: a condition decision-making means for determining that a flow rate restricting condition has been established when a traveling operation quantity equal to or greater than a predetermined value is detected by the traveling operation quantity detection means and a work operation quantity equal to or greater than a predetermined value is detected by the work operation quantity detection means; and an enabling/disabling means for enabling the valve control means to control the flow control valve when the condition decision-making means determines that the flow rate restricting condition has been established and disabling control of the flow control valve by the valve control means when the condition decision-making means determines that the flow rate restricting condition has not been established.

[0014] According to a fourth aspect of the present invention, the traveling control device for a wheeled work vehicle according to any one of the first to third aspects may further comprise: a reduction mechanism, capable of altering a reduction ratio, that slows down rotation of the traveling motor and transmits the slowed rotation to wheels; a reduction ratio detection means for detecting the reduction ratio at the reduction mechanism; a condition decision-making means for determining that a flow rate restricting condition has been established when a traveling operation quantity equal to or greater than a predetermined value is detected by the traveling operation quantity detection means, a work operation quantity equal to or greater than a predetermined value is detected by the work operation quantity detection means and a reduction ratio equal to or greater than a predetermined value is detected by the reduction ratio detection means; and an enabling/disabling means for enabling the valve control means to control the flow control valve when the

condition decision-making means determines that the flow rate restricting condition has been established and disabling control of the flow control valve by the valve control means when the condition decision-making means determines that the flow rate restricting means has not been established.

BRIEF DESCRIPTION OF THE DRAWINGS

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FIG. 1 is a side elevation of a wheel excavator adopting the traveling control device according to the present invention.

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FIG. 2 schematically illustrates the structure of the traveling control device achieved in a first embodiment.

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FIG. 3 is a block diagram showing the structure of the traveling control device achieved in the first embodiment.

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FIGS. 4A to 4E present diagrams indicating the characteristics based upon which the arithmetic operations are executed in the various arithmetic operation units shown in FIG. 3.

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FIG. 5 is a block diagram showing the structure of the traveling control device achieved in a second embodiment.

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FIG. 6 schematically illustrates the structure of the traveling control device achieved in a third embodiment.

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FIG. 7 is a block diagram showing the structure of the traveling control device achieved in the third embodiment.

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FIG. 8 presents a graph indicating the characteristics based upon which an arithmetic operation is executed in the fourth arithmetic operation unit shown in FIG. 7.

DESCRIPTION OF PREFERRED EMBODIMENTS

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[0016] The following is a description of an embodiment of a wheeled work vehicle that adopts the traveling control device according to the present invention, given in reference to drawings.

- First Embodiment -

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[0017] FIG. 1 is a side elevation of a wheeled hydraulic excavator (hereafter notated as a wheel excavator 100), representing an example of the wheeled work vehicle achieved in the embodiment. It is to be noted that in the

following description, the directional terms front/rear and up/down will be used as defined in FIG. 1.

[0018] The wheel excavator 100 includes a traveling superstructure 101 and a revolving superstructure 102 rotatably mounted upon the traveling superstructure 101. A traveling hydraulic motor (hereafter referred to as a "traveling motor") is installed in the traveling superstructure 101, and wheels 105 rotate as they are driven by the traveling motor. An operator's cab 104 and a front work device 110 are disposed at the revolving superstructure 102. At the rear of the revolving superstructure 102, a counterweight 109, used to balance the body during work operation, is mounted.

[0019] The front work device 110 includes a boom 106, an arm 107 and a bucket 108. The boom 106 and the arm 107 move up or down as they are driven by a boom cylinder 116 and an arm cylinder 117 respectively. The bucket 108, attached at the front end of the arm 107 so as to be allowed to swivel up/down relative to the arm 107, is driven by a bucket cylinder 118.

[0020] FIG. 2 is a diagram schematically illustrating the structure of the traveling control device. Pressure oil (or pressurized oil) output from a main pump 130 driven by an engine 190 is delivered via a valve unit 140 to a traveling motor 115, the boom cylinder 116 and the arm cylinder 117. The traveling motor 115, the boom cylinder 116 and the arm cylinder 117 are driven with the pressure oil delivered thereto.

[0021] The valve unit 140 includes a traveling directional control valve 145, a boom directional control valve 146 and an arm directional control valve 147, which are all open center type directional control valves that control the flow of pressure oil delivered to the traveling motor 115, the boom cylinder 116 and the arm cylinder 117 respectively. The valve unit 140 further includes a variable restrictor 161 capable of adjusting the area of an opening through which the pressure oil is distributed. The various directional control valves 145, 146 and 147 are all disposed on a center bypass line 191 connecting the main pump 130 with a tank (or a reservoir) 199. Namely, the traveling directional control valve 145, the boom directional control valve 146 and the arm directional control valve 147 are connected in tandem to the center bypass line 191.

[0022] The directional control valves 145, 146 and 147 are connected in parallel through a parallel oil passage 192 branching out from the center bypass line 191 on the upstream side of the traveling directional control valve 145. The variable restrictor 161 is disposed in a feeder oil passage 193 branching out from the parallel oil passage 192 and connected to the traveling directional control valve 145. The variable restrictor 161 controls the flow rate of pressure oil delivered to the traveling motor 115. The variable restrictor 161 takes positions between a position (A) at which the pressure oil flow opening achieves the maximum area and a position (B) at which the pressure oil flow opening area is restricted to assume the smallest area.

[0023] The variable restrictor 161 is made to move between a position (A) and a position (B) via an electromagnetic proportional valve 162 engaged in operation by a control signal provided from a controller 120. In other words, the operation of the variable restrictor 161 is controlled by the electromagnetic proportional valve 162 and the controller 120.

[0024] The electromagnetic proportional valve 162 is disposed in a pilot pipeline connecting a pilot pump 131 driven by the engine 190 and a pilot portion of the variable restrictor 161. The electromagnetic proportional valve 162 is displaced between a position (A) at which pressure oil from the pilot pump 131 is delivered to the pilot portion of the variable restrictor 161 and a position (B) at which the pressure oil from the pilot pump 131 is cut off. When the electric current input to the solenoid in the electromagnetic proportional valve 162 from the controller 120 is represented by a greater value, the extent of displacement from the position (B) toward the position (A), too, is greater, and once the current is no longer supplied to the solenoid, a reset spring switches the electromagnetic proportional valves 162 to the position (B).

[0025] The pressure oil from the pilot pump 131 is delivered to pilot valves disposed at a traveling operation pedal 155, a boom operation lever 156 and an arm operation lever 157. As a given operation member among the operation members 155, 156 and 157 is operated, a secondary pilot pressure is generated via the corresponding pilot valve. The secondary pilot pressure thus generated via the particular pilot valve is applied to the corresponding pilot port at the traveling directional control valve 145, the boom directional control valve 146 or the arm directional control valve 147. Thus, in correspondence to the operation quantity representing the extent to which a given operation member among the operation members 155, 156 and 157 is operated, the spool in the directional control valve 145, 146 or 147, corresponding to the operation member 155, 156 or 157 having been operated, is driven.

[0026] It is to be noted that in this embodiment, the degree of opening at the traveling directional control valve 145 is controlled in correspondence to the operation quantity at the traveling operation pedal 155 and that as the operation quantity at the traveling operation pedal 155 increases, the flow rate of the pressure oil delivered to the traveling motor 115 increases to result in an increase in the rotation rate of the traveling motor 115.

[0027] The wheel excavator 100 is equipped with a transmission 150 capable of reduction ratio adjustment. The rotation of the traveling motor 115, first slowed down at the transmission 150, is transmitted to the wheels 105 via a drive shaft (not shown) and axles (not shown), thereby enabling the wheel excavator 100 to travel.

[0028] The transmission 150 is a system of the known art that includes a planetary reduction gear unit configured with a sun gear, a planetary gear and a ring gear (none shown), and clutches 150a and 150b disposed on the sun gear side and on the ring gear side. Although not

shown, the clutches 150a and 150b each include a clutch cylinder with a built-in spring. As the clutch cylinder is pressed onto a disk with the force imparted by the spring, the corresponding clutch 150a or 150b is set in an engaged state. The clutches 150a and 150b are each set in a released state as a hydraulic force imparted from the pilot pump 131, which acts against the spring force, cancels out the pressing force imparted at the clutch cylinder. The hydraulic force that acts on the clutches 150a and 150b is controlled via the drive of an electromagnetic switching valve 151. It is to be noted that a clutch set in an engaged state by the force imparted by a spring and set in a released state by a hydraulic force is referred to as a negative-type clutch.

[0029] The electromagnetic switching valve 151 is switched by a control signal output from the controller 120 in response to an operation at a speed change switch 158. As the electromagnetic switching valve 151 is switched to a position (A), the pressure oil from the pilot pump 131 acts on the clutch 150a. As a result, the clutch 150a is released and the clutch 150b enters the engaged state, thereby setting a predetermined reduction ratio R1 (low gear) at the transmission 150 and enabling first speed traveling at low speed and high torque.

[0030] As the electromagnetic switching valve 151 is switched to a position (B), the pressure oil from the pilot pump 131 acts on the clutch 150b. As a result, the clutch 150b is released and the clutch 150a enters the engaged state, thereby setting a predetermined reduction ratio R2 (high gear) at the transmission 150 and enabling second speed traveling at high speed and low torque. It is to be noted that the reduction ratio R1 is greater than the reduction ratio R2.

[0031] As the electromagnetic switching valve 151 is switched to a position (C), the clutches 150a and 150b are set in communication with the tank 199. In this situation, the clutch 150a and the clutch 150b are sustained in the engaged state by the respective spring forces, and the transmission 150 is locked, thereby disallowing rotation of the drive shaft.

[0032] The controller 120, configured so as to include an arithmetic processing device having a CPU, storage devices such as a ROM and a RAM, other peripheral circuits and the like, controls the overall system in the wheel excavator 100.

[0033] A pressure sensor 172 used to detect either the operation quantity at the boom operation lever 156 or the operation quantity at the arm operation lever 157 that is greater than the other, a pressure sensor 171 used to detect the operation quantity at the traveling operation pedal 155, the speed change switch 158, and a pressure sensor 173 used to detect the output pressure at the main pump 130 are connected to the controller 120.

[0034] A plurality of high pressure selection valves 196, 197 and 198 are disposed between the pressure sensor 172 and the two operation levers, i.e., the boom operation lever 156 and the arm operation lever 157, and the highest pressure among the secondary pilot pressures output

from the respective pilot valves in the boom operation lever 156 and the arm operation lever 157 is detected at the pressure sensor 172.

[0035] A high pressure selection valve 195 is disposed between the pressure sensor 171 and the traveling operation pedal 155, and the higher pressure of the secondary pilot pressures output from the pilot valves at the traveling operation pedal 155 as a forward instruction signal and a backward instruction signal is detected by the pressure sensor 171.

[0036] The speed change switch 158 is an operation switch operated to set the transmission 150 to first gear with a greater reduction ratio or to second gear with a smaller reduction ratio. As the speed change switch 158 is operated to the first speed position, it outputs a signal for setting the transmission 150 to low gear and provides the signal to the controller 120. Upon detecting that the speed change switch 158 has been operated to the first speed position, the controller 120 outputs a control signal for switching the electromagnetic switching valve 151 to the position (A). As the speed change switch 158 is operated to the second speed position, it outputs a signal for setting the transmission 150 to high gear and provides the signal to the controller 120. Upon detecting that the speed change switch 158 has been operated to the second speed position, the controller 120 outputs a control signal for switching the electromagnetic switching valve 151 to the position (B).

[0037] FIG. 3 is a block diagram showing the structure of the traveling control device achieved in the first embodiment. FIGS. 4A to 4E indicate the characteristics based upon which the arithmetic operations are executed in the various arithmetic operation units shown in FIG. 3. The controller 120 includes a first arithmetic operation unit 123 that calculates an opening area A_d at the variable restrictor 161 based upon a pressure P_d detected via the pressure sensor 171, a second arithmetic operation unit 124 that calculates an opening area A_f at the variable restrictor 161 based upon a pressure P_f detected via the pressure sensor 172 and a third arithmetic operation unit 125 that calculates an opening area A_p at the variable restrictor 161 based upon a pressure P_p detected via the pressure sensor 173, all embodied as functional units.

[0038] Based upon predetermined characteristics f_1 indicated in FIG. 4A, the first arithmetic operation unit 123 calculates the opening area A_d at the variable restrictor 161 that monotonically increases as the detection value P_d provided by the pressure sensor 171 (hereafter may be otherwise referred to as a "traveling operation pressure") increases. As FIG. 4A indicates, the characteristics f_1 are such that while the opening area A_d is represented by the minimum value A_{min} as long as the detection value P_d is equal to or less than a predetermined value P_{d1} , the opening area A_d increases exponentially from the minimum value A_{min} through the maximum value A_{max} as the detection value P_d increases over a range between P_{d1} and P_{d2} . The graph representing the characteristics f_1 indicates that once the de-

tection value P_d becomes equal to or greater than the predetermined value P_{d2} , the opening area A_d sustains the maximum value A_{max} .

[0039] Based upon predetermined characteristics f_2 indicated in FIG. 4B, the second arithmetic operation unit 124 calculates the opening area A_f at the variable restrictor 161 that monotonically decreases as the detection value P_f provided by the pressure sensor 172 (hereafter may be otherwise referred to as a "front operation pressure") increases. As FIG. 4B indicates, the characteristics f_2 are such that while the opening area A_f is represented by the maximum value A_{max} as long as the detection value P_f is equal to or less than a predetermined value P_{f1} , the opening area A_f decreases exponentially from the maximum value A_{max} through the minimum value A_{min} as the detection value P_f increases over a range between P_{f1} and P_{f2} . The graph representing the characteristics f_2 indicates that once the detection value P_f becomes equal to or greater than the predetermined value P_{f2} , the opening area A_f sustains the minimum value A_{min} .

[0040] Based upon predetermined characteristics f_3 indicated in FIG. 4C, the third arithmetic operation unit 125 calculates the opening area A_p at the variable restrictor 161 that monotonically decreases as the detection value P_p provided by the pressure sensor 173 (hereafter may be otherwise referred to as a "pump output pressure") increases. As FIG. 4C indicates, the characteristics f_3 are such that while the opening area A_p is represented by the maximum value A_{max} as long as the detection value P_p is equal to or less than a predetermined value P_{p1} , the opening area A_p decreases exponentially from the maximum value A_{max} through the minimum value A_{min} as the detection value P_p increases over a range between P_{p1} and P_{p2} . The graph representing the characteristics f_3 indicates that once the detection value P_p becomes equal to or greater than the predetermined value P_{p2} , the opening area A_p sustains the minimum value A_{min} .

[0041] As shown in FIG. 3, the controller 120 further includes a maximum value selection unit 126 and a minimum value selection unit 127 both embodied as functional units. The maximum value selection unit 126 compares the opening area A_d calculated by the first arithmetic operation unit 123 and the opening area A_f calculated by the second arithmetic operation unit 124 and selects either the opening area A_d or the opening area A_f that is greater than the other as a first opening area A_1 .

[0042] The minimum value selection unit 127 compares the first opening area A_1 selected by the maximum value selection unit 126 and the opening area A_p calculated by the third arithmetic operation unit 125 and selects either the first opening area A_1 or the opening area A_p that is smaller than the other as a target opening area A_t .

[0043] The controller 120 further includes functional units embodying a traveling operation decision-making unit 121 that makes a decision, based upon the pressure P_d detected by the pressure sensor 171, as to whether

or not the traveling operation pedal 155 has been operated, a work operation decision-making unit 122 that makes a decision, based upon the pressure P_f detected by the pressure sensor 172, as to whether or not a work operation lever 156 or 157 has been operated, and a condition decision-making unit 180 that makes a decision, based upon the decision-making results provided by the traveling operation decision-making unit 121 and the work operation decision-making unit 122, as to whether or not a flow rate restricting condition has been established. The controller 120 also includes a maximum value setting unit 182 that sets the target opening area A_t to the maximum value A_{max} and a switch unit 181 that is switched based upon the decision-making results provided by the condition decision-making unit 180, both embodied as functional units.

[0044] The traveling operation decision-making unit 121 makes a decision as to whether or not the pressure P_d detected by the pressure sensor 171 is equal to or greater than a threshold value P_{t1} . The threshold value P_{t1} is stored in a storage device in advance ($P_{t1} \leq P_{d1}$). The threshold value P_{t1} is a threshold value used as a criterion when making a decision as to whether or not a traveling operation is underway. The threshold value P_t is set by taking into consideration a secondary pilot pressure generated via the pilot valve at the traveling operation pedal 155, at which the wheel excavator 100 starts traveling. The traveling operation decision-making unit 121 decides that no traveling operation is underway if the pressure P_d detected by the pressure sensor 171 is less than the threshold value P_{t1} , whereas it decides that a traveling operation is underway if the pressure P_d detected by the pressure sensor 171 is equal to or greater than the threshold value P_{t1} .

[0045] The work operation decision-making unit 122 makes a decision as to whether or not the pressure P_f detected by the pressure sensor 172 is equal to or greater than a threshold value P_{t2} . The threshold value P_{t2} is stored in advance in a storage device ($P_{t2} \leq P_{f1}$). The threshold value P_{t2} is a threshold value used as a criterion when making a decision as to whether or not the front work device 110 is currently engaged in operation. The threshold value P_{t2} is set by taking into consideration secondary pilot pressures generated via the pilot valves at the work operation levers 156 and 157 at which the front work device 116 starts drive. The work operation decision-making unit 122 decides that no work operation is underway if the pressure P_f detected by the pressure sensor 172 is less than the threshold value P_{t2} and decides that a work operation is underway if the pressure P_f detected by the pressure sensor 172 is equal to or greater than the threshold value P_{t2} .

[0046] The condition decision-making unit 180 makes a decision, based upon signals provided by the work operation decision-making unit 122 and the traveling operation decision-making unit 121, as to whether or not a combination operation is underway, i.e., whether or not a work operation and a traveling operation are both per-

formed. Upon deciding that a combination operation is performed, the condition decision-making unit 180 determines that a flow rate restricting condition has been established and outputs an ON signal to the switch unit 181. In response to the ON signal input thereto, the switch unit 181 is switched toward a terminal (A). Upon deciding, based upon the signals provided by the work operation decision-making unit 122 and the traveling operation decision-making unit 121, that a work operation is not underway or a traveling operation is not underway, the condition decision-making unit 180 determines that the flow rate restricting condition has not been established and outputs an OFF signal to the switch unit 181. In response to the OFF signal input thereto, the switch unit 181 is switched toward a terminal (B).

[0047] In addition, the controller 120 includes a functional unit embodying a control pressure calculation unit 128 that calculates a control pressure P_v for the electromagnetic proportional valve 162, which corresponds to either the target opening area A_t that is selected by the minimum value selection unit 127 and is output via the switch unit 181 when the flow rate restricting condition exists or the target opening area A_t that is set by the maximum value setting unit 182 and is output via the switch unit 181 when the flow rate restricting condition does not exist.

[0048] The control pressure calculation unit 128 calculates the control pressure P_v corresponding to the target opening area A_t based upon predetermined characteristics f_4 indicated in FIG. 4D. As FIG. 4D indicates, the characteristics f_4 are such that the electromagnetic valve control pressure P_v increases exponentially from a minimum value P_{vmin} through a maximum value P_{vmax} as the target opening area A_t increases over a range between A_{min} and A_{max} .

[0049] The controller 120 further includes a functional unit embodying a current calculation unit 129 that calculates a control current I to be output to the electromagnetic proportional valve 162, which corresponds to the control pressure P_v calculated for the electromagnetic proportional valve 162 by the control pressure calculation unit 128.

[0050] The current calculation unit 129 calculates the control current I corresponding to the control pressure P_v based upon predetermined characteristics f_5 indicated in FIG. 4E. As FIG. 4E indicates, the characteristics f_5 are such that the control current I increases exponentially from a minimum value $I_{min} = 0$ through a maximum value I_{max} as the control pressure P_v increases over a range between P_{vmin} and P_{vmax} .

[0051] When the switch unit 181 is set at the position (A), the controller 120 outputs the control current I calculated by the current calculation unit 129 to the electromagnetic proportional valve 162 to control the variable restrictor 161 so that the opening area at the variable restrictor 161 matches the opening area having been selected by the minimum value selection unit 127.

[0052] As the wheel excavator shifts from a traveling

operation-only state, in which the traveling operation pedal 155 is operated but neither the boom operational lever 156 nor the arm operation lever 157 is operated, to a combination operation state in which the traveling operation pedal 155 is operated and the boom operation lever 156 or the arm operation lever 157 is also operated, the controller 120 controls the variable restrictor 161 so that the opening area at the variable restrictor 161 becomes smaller than that in the traveling operation-only state, thereby minimizing or preventing the bucking phenomenon at the wheel excavator 100.

[0053] The primary operations of the traveling control device for the wheel excavator 100 achieved in the first embodiment will be described next.

[0054] While neither the boom operation lever 156 nor the arm operation lever 157 is operated, the front operation pressure P_f remains equal to or less than P_{f1} . Accordingly, the work operation decision-making unit 122 in the controller 120 decides that no work operation is underway. While the traveling operation pedal 155 is not operated, the traveling operation pressure P_d remains equal to or less than P_{d1} . Accordingly, the traveling operation decision-making unit 121 in the controller 120 decides that no traveling operation is underway. Under these circumstances, based upon the decision-making results provided by the work operation decision-making unit 122 and the traveling operation decision-making unit 121, the condition decision-making unit 180 decides that the flow rate restricting condition has not been established.

[0055] When the flow rate restricting condition is not present, the controller 120 switches the switch unit 181 to the position (B) so as to set the target opening area A_t for the variable restrictor 161 to the maximum value A_{max} by cutting off the minimum value selection unit 127 from the control pressure calculation unit 128. The controller 120 then executes processing for outputting the control current $I = I_{max}$ to the solenoid in the electromagnetic proportional valve 162. As a result, the electromagnetic proportional valve 162 is switched to the position (A) and the variable restrictor 161 is switched to the position (A).

[0056] As the traveling operation pedal 155 in the wheel excavator in this non-operating state is operated to a very small extent, the spool in the traveling directional control valve 145 becomes displaced in correspondence to the operation quantity at the traveling operation pedal 155, and, as a result, pressure oil output from the main pump 130 is delivered to the traveling motor 115 via the traveling directional control valve 145. The pressure oil delivered to the traveling motor 115 rotationally drives the traveling motor 115 and the wheel excavator 100 thus starts to travel.

[0057] In the traveling operation-only state in which no front work operation is in progress, the work operation decision-making unit 122 decides that no work operation is underway. Based upon these decision-making results, the condition decision-making unit 180 decides that the

flow rate restricting condition has not been established and accordingly, the variable restrictor 161 is held at the position (A).

[0058] If the operator operates, for instance, the boom operation lever 156 to the UP side while the wheel excavator is traveling at low speed, the operation of the boom operation lever 156 is detected by the pressure sensor 172 and the detection results are input to the controller 120. The work operation decision-making unit 122 accordingly decides that a front work operation is underway and the traveling operation decision-making unit 121 decides that a traveling operation is underway. Based upon these decision-making results, the condition decision-making unit 180 decides that the flow rate restricting condition has been established.

[0059] Once it is decided that the flow rate restricting condition has been established, the switch unit 181 is switched to the position (A) at which the minimum value selection unit 127 and the control pressure calculation unit 128 are connected with each other, and thus, the opening area selected by the minimum value selection unit 127 is input to the control pressure calculation unit 128 as the target opening area A_t .

[0060] While the wheel excavator is traveling at low speed, the flow rate of the pressure oil delivered to the traveling motor 115 is restricted via the variable restrictor 161 controlled so as to achieve either the opening area calculated in correspondence to the operation quantity at the work operation lever 156 or 157 or the opening area calculated in correspondence to the pump output pressure P_p that is smaller than the other.

[0061] For instance;

(α) when the traveling operation pressure P_d and the front operation pressure P_f are both low (e.g., $P_{t1} \leq P_d \leq P_{d1}$ and $P_{t2} \leq P_f \leq P_{f1}$) and the pump output pressure P_p is high (e.g., $P_p \geq P_{p2}$), the variable restrictor 161 is switched to the position (B). During a boom raising operation or the like performed with the bucket 108 carrying a heavy load such as soil, the pump output pressure P_p tends to become high and thus the bucking phenomenon tends to occur readily at the wheel excavator 100. In the embodiment, even when the operation quantities at the front operation device are not significant, the flow rate of the pressure oil to be delivered to the traveling motor 115 is restricted via the variable restrictor 161 if the pump output pressure P_p is high.

(β) when the traveling operation pressure P_d is low and the front operation pressure P_f is high (e.g., $P_{t1} \leq P_d \leq P_{d1}$ and $P_f \geq P_{f2}$), the variable restrictor 161 is switched to the position (B) regardless of the pump output pressure P_p . If the front work device is operated to the full extent while the traveling operation pedal is operated to a very slight extent, the pump output pressure P_p increases, following the operation at the front work device and, accordingly, the flow rate of the pressure oil to be delivered to the

traveling motor 115 is restricted by the variable restrictor 161.

[0062] As described above, as the wheel excavator shifts from the traveling operation-only state to the combination operation state, the variable restrictor 161 is switched to the position (B) and, as a result, the flow rate of the pressure oil delivered to the traveling motor 115 is reduced compared to that in the traveling operation-only state. Thus, an increase in the flow rate of pressure oil delivered to the traveling motor 115, attributable to an operation at the front work device, can be minimized while the wheel excavator 100 is traveling at low speed. In other words, the severity of bucking occurring at the wheel excavator 100, occurring as a front work operation is performed while the wheel excavator 100 is traveling, is reduced or prevented altogether.

[0063] The following advantages are achieved through the first embodiment described above.

(1) The variable restrictor 161 is controlled in correspondence to the traveling operation pressure P_d , the front operation pressure P_f and the output pressure P_p at the main pump 130. The controller 120 controls the variable restrictor 161 so as to achieve a smaller opening area at the variable restrictor 161 by outputting the control current to the electromagnetic proportional valve 162 when the wheel excavator in the traveling operation-only state, in which the traveling operation pedal 155 is operated but neither the boom operation lever 156 nor the arm operation lever 157 is operated shifts into the combination operation state in which the traveling operation pedal 155 is operated and the boom operation lever 156 or the arm operation lever 157 is also operated. In other words, in this embodiment, the controller 120, the electromagnetic proportional valve 162 and the variable restrictor 161 control the flow rate of pressure oil delivered to the traveling motor 115 in order to deter the bucking phenomenon at the wheel excavator 100.

When the traveling operation pressure P_d is low (e.g., $P_{t1} \leq P_d \leq P_{d1}$), the variable restrictor 161 is controlled by setting either the opening area A_f , calculated based upon the front operation pressure P_f , or the opening area A_p , calculated based upon the output pressure P_p at the main pump 130, that is smaller than the other as the target opening area A_t . When the traveling operation pressure P_d is low (e.g., $P_{t1} \leq P_d \leq P_{d1}$), the variable restrictor 161 is controlled so as to achieve a smaller opening area as the front operation pressure P_f increases or as the pump output pressure P_p increases.

Through these measures, the severity of bucking occurring at the wheel excavator 100 in a traveling state as an operation other than the traveling operation (i.e., a boom raising operation or an arm raising operation) is performed can be reduced or eliminated

altogether. As a result, a comfortable ride can be assured for the operator driving the wheel excavator 100.

(2) The controller 120 determines that the flow rate restricting condition has been established if a traveling operation pressure P_d equal to or greater than the predetermined value P_{t1} is detected and also a front operation pressure P_f equal to or greater than the predetermined value P_{t2} is detected. Upon determining that the flow rate restricting condition has been established, the controller 120 switches the switch unit 181 to the position (A) so as to enable control under which the flow rate is restricted via the variable restrictor 161 in correspondence to the traveling operation pressure P_d , the front operation pressure P_f and the pump output pressure P_p . If, on the other hand, it is determined that the flow rate restricting condition has not been established, the controller 120 switches the switch unit 181 to the position (B) so as to disable the control for restricting the flow rate via the variable restrictor 161.

[0064] In the embodiment described above, the flow rate of pressure oil delivered to the traveling motor 115 is never restricted via the variable restrictor 161 in the traveling operation-only state. For instance, even as the pump output pressure P_p rises while the wheel excavator is traveling uphill, the opening area at the variable restrictor 161 does not decrease in conformance to the characteristics f_3 and thus, the traveling drive force does not become lowered.

- Second Embodiment -

[0065] The traveling control device achieved in the second embodiment of the present invention will be described in reference to FIG. 5. The following description will focus on the features of the second embodiment differentiating it from the first embodiment, with the same reference numerals assigned to elements identical or equivalent to those in the first embodiment. FIG. 5 shows the structure of the traveling control device achieved in the second embodiment of the present invention in a block diagram similar to that presented in FIG. 3.

[0066] In the first embodiment, the condition decision-making unit 180 makes a decision as to whether or not the flow rate restricting condition has been established based upon the decision-making results provided by the traveling operation decision-making unit 121 and the work operation decision-making unit 122. The second embodiment is distinguishable in that a condition decision-making unit 280 makes a decision as to whether or not the flow rate restricting condition has been established based upon decision-making results provided by a reduction ratio decision-making unit 283 in addition to the decision-making results provided by the traveling operation decision-making unit 121 and the work operation decision-making unit 122.

[0067] The controller 120 includes a functional unit embodying the reduction ratio decision-making unit 283 that makes a decision, in response to a control signal output from the speed change switch 158, as to whether or not the reduction ratio is equal to or greater than a predetermined value. When the speed change switch 158 is set at first speed position, the reduction ratio decision-making unit 283 decides that the reduction ratio is equal to or greater than the predetermined value, whereas if the speed change switch 158 is set at second speed position, the reduction ratio decision-making unit 283 decides that the reduction ratio is less than the predetermined value.

[0068] The condition decision-making unit 280 makes a decision, based upon signals provided by the work operation decision-making unit 122 and the traveling operation decision-making unit 121, as to whether or not the combination operation is underway, i.e., both a work operation and a traveling operation are currently in progress, and also makes a decision, based upon a signal provided by the reduction ratio decision-making unit 283, as to whether or not the reduction ratio is equal to or greater than the predetermined value. Upon deciding that the combination operation is underway and the reduction ratio is equal to or greater than the predetermined value, the condition decision-making unit 280 determines that the flow rate restricting condition has been established and outputs an ON signal to the switch unit 181. In response to the ON signal input thereto, the switch unit 181 is switched toward the terminal (A). Upon determining, based upon the signals provided by the work operation decision-making unit 122, the traveling operation decision-making unit 121 and the reduction ratio decision-making unit 283, that a work operation or a traveling operation is not currently underway or that the reduction ratio is less than the predetermined value, the condition decision-making unit 280 decides that the flow rate restricting condition has not been established, and outputs an OFF signal to the switch unit 181. In response to the OFF signal input thereto, the switch unit 181 is switched toward the terminal (B).

[0069] As described above, the controller 120 in the second embodiment determines that the flow rate restricting condition has been established if a traveling operation pressure P_d equal to or greater than the predetermined value P_{t1} is detected, a front operation pressure P_f equal to or greater than the predetermined value P_{t2} is detected and a reduction ratio equal to or greater than the predetermined value is detected. Upon determining that the flow rate restricting condition has been established, the controller 120 switches the switch unit 181 to the position (A) so as to enable control under which the flow rate is restricted via the variable restrictor 161 in correspondence to the traveling operation pressure P_d , the front operation pressure P_f and the pump output pressure P_p . If, on the other hand, it is determined that the flow rate restricting condition has not been established, the controller 120 switches the switch unit 181 to the position (B) so as to disable the control for restricting the

flow rate via the variable restrictor 161.

[0070] In addition to advantages similar to those of the first embodiment, the second embodiment described above further achieves the following advantage. The bucking phenomenon occurs as the output pressure at the main pump 130 is applied to the low pressure-side traveling motor 115, rather than to the actuators for the high pressure-side front operation device in response to a work operation performed to, for instance, raise the boom while the work vehicle is traveling at crawling speed (i.e., very low speed) or at low speed, at which the traveling drive pressure is relatively low. In the second embodiment, flow rate restriction control, under which the flow rate of pressure oil to be delivered to the traveling motor 115 is restricted via the variable restrictor 161, is executed when the reduction ratio is high, i.e., when the traveling motor drive pressure is low, so as to reduce the extent of the bucking phenomenon or prevent it altogether. However, when the reduction ratio is low, i.e., when the traveling motor drive pressure is high, the bucking phenomenon does not occur as readily as under the high reduction ratio condition. Accordingly, the flow rate restriction control under which the flow rate of pressure oil to be delivered to the traveling motor 115 is restricted via the variable restrictor 161 is not executed. Through these measures, it is ensured that the drive force of the traveling motor 115 is not lowered as the work vehicle shifts from the traveling operation-only state into the combination operation state under the low reduction ratio condition.

- Third Embodiment -

[0071] The traveling control device achieved in the third embodiment of the present invention will be described in reference to FIG. 6. The following description will focus on the features of the third embodiment differentiating it from the first embodiment, with the same reference numerals assigned to elements identical or equivalent to those in the first embodiment. FIG. 6 illustrates the structure of the traveling control device achieved in the third embodiment of the present invention in a schematic diagram similar to that presented in FIG. 2.

[0072] The traveling control device achieved in the third embodiment includes a pressure sensor 374 that detects the pressure in either a main pipeline LA or a main pipeline LB at the traveling motor 115, selected via a high-pressure selection valve 394, i.e., the pressure (traveling drive pressure P_m) of the pressure oil delivered to the traveling motor 115. In response to an operation of the work operation lever 156 or 157 performed while the work vehicle is traveling, the flow rate of pressure oil delivered to the traveling motor 115 increases, and the extent of this increase in flow rate is greater if the traveling drive pressure P_m is lower by a greater extent relative to the work load pressure. Accordingly, the opening area at the variable restrictor 161 is set in the third embodiment by factoring in characteristics f_6 whereby the opening area is reduced as the traveling drive pressure P_m be-

comes lower and the opening area is increased as the traveling drive pressure P_m becomes higher.

[0073] FIG. 7 shows the structure of the traveling control device achieved in the third embodiment of the present invention in a block diagram similar to that presented in FIG. 3. FIG. 8 presents a diagram indicating characteristics representing the relationship between the traveling drive pressure P_m and an opening area A_m , based upon which the arithmetic operation is executed in a fourth arithmetic operation unit 384 shown in FIG. 7.

[0074] The controller 120 in the third embodiment includes functional units embodying the fourth arithmetic operation unit 384 that calculates the opening area A_m for the variable restrictor 161 based upon the pressure P_m detected by the pressure sensor 374, a maximum value selection unit 326 and a minimum value selection unit 327.

[0075] The fourth arithmetic operation unit 384 calculates, based upon the predetermined characteristics f_6 shown in FIG. 8, the opening area A_m at the variable restrictor 161 that monotonically increases as the detection value (traveling drive pressure) P_m provided by the pressure sensor 374 increases. As indicated in FIG. 8, the characteristics f_6 are such that while the detection value P_m remains equal to or less than a predetermined value P_{m1} , the opening area A_m is sustained at a minimum value A_{min} and that the opening area A_m increases exponentially from the minimum value A_{min} through a maximum value A_{max} as the detection value P_m increases over a detection value range between P_{m1} and P_{m2} . The opening area A_m taking on the characteristics f_6 is sustained at the maximum value A_{max} once the detection value P_m becomes equal to or greater than the predetermined value P_{m2} .

[0076] The maximum value selection unit 326 compares the opening area A_p calculated by the third arithmetic operation unit 125 with the opening area A_m calculated by the fourth arithmetic operation unit 384 and selects either the opening area A_p or the opening area A_m that is greater than the other as a second opening area A_2 .

[0077] The minimum value selection unit 327 compares the first opening area A_1 selected by the maximum value selection unit 126 with the second opening area A_2 selected by the maximum value selection unit 326 and selects either the first opening area A_1 or the second opening area A_2 that is smaller than the other as the target opening area A_t .

[0078] In the first embodiment, the variable restrictor 161 is switched to the position (B) when the traveling operation pressure P_d and the front operation pressure P_f are both low (e.g., $P_{t1} \leq P_d \leq P_{d1}$ and $P_{t2} \leq P_f \leq P_{f1}$) and the pump output pressure P_p is high (e.g., $P_p \geq P_{p2}$). In the third embodiment, the variable restrictor 161 is switched to the position (A) if the traveling drive pressure P_m is high (e.g., $P_m \geq P_{m2}$) even when the traveling operation pressure P_d and the front operation pressure P_f are both low (e.g., $P_{t1} \leq P_d \leq P_{d1}$ and $P_{t2} \leq P_f \leq P_{f1}$).

and the pump output pressure P_p is high (e.g., $P_p \geq P_{p2}$).

[0079] The third embodiment is characterized as follows;

(α) The variable restrictor 161 is switched to the position (B) if the traveling drive pressure P_m is low (e.g., $P_m \leq P_{m1}$) while the traveling operation pressure P_d and the front operation pressure P_f are both low and the pump output pressure P_p is high (e.g., $P_{t1} \leq P_d \leq P_{d1}$, $P_{t2} \leq P_f \leq P_{f1}$ and $P_p \geq P_{p2}$). As a result, the extent of the bucking phenomenon is reduced or eliminated altogether, even if the boom operation lever 156 is operated to a very small extent to engage the work vehicle in heavy-load work while the work vehicle is traveling on flat ground at low speed. When the traveling drive pressure P_m is high (e.g., $P_m \geq P_{m2}$), the variable restrictor 161 is switched to the position (A). Thus, even if the boom operation lever 156 is operated to a small extent to engage the work vehicle in heavy-load work while the work vehicle is traveling uphill at low speed, the traveling drive force does not become lowered.

In addition, if, for instance, the boom operation lever 156 is operated to a very small extent to engage the work vehicle in heavy-load work while the work vehicle is traveling on flat ground at low speed, the opening area of the variable restrictor 161 is reduced as the pump output pressure P_p rises rapidly, so as to reduce the extent of the bucking phenomenon or prevent it altogether. Subsequently, as the motor drive pressure P_m , too, rises in response to the increase in the pump output pressure P_p , the opening area at the variable restrictor 161 increases in correspondence to the increase in the motor drive pressure P_m , and thus, the traveling drive force does not become lowered.

(β) If the traveling operation pressure P_d is low but the front operation pressure P_f is high (e.g., $P_{t1} \leq P_d \leq P_{d1}$ and $P_f \geq P_{f2}$), the variable restrictor 161 is switched to the position (B) regardless of the pump output pressure P_p and the traveling drive pressure P_m . This means that if, for instance, the boom operation lever 156 is operated to the full extent while the work vehicle is traveling at very low speed, the pump output pressure P_p increases following the operation at the front work device, and in this situation, the extent of the bucking phenomenon at the wheel excavator 100 can be reduced or eliminated altogether by restricting, via the variable restrictor 161, the flow rate of pressure oil to be delivered to the traveling motor 115.

[0080] In addition to advantages similar to those of the first embodiment, the third embodiment described above further achieves the following advantage. The bucking phenomenon occurs as the output pressure at the main pump 130 is applied to the low pressure-side traveling motor 115, rather than to the actuators for the high pres-

sure-side front operation device in response to a work operation performed to, for instance, raise the boom while the work vehicle is traveling at crawling speed or at low speed, at which the traveling drive pressure is relatively low. In the third embodiment, flow rate restriction control under which the flow rate of pressure oil to be delivered to the traveling motor 115 is restricted by the variable restrictor 161 is executed in order to reduce the extent of the bucking phenomenon or prevent it altogether, if, for instance, the boom operation lever 156 is operated to a very small extent (e.g., $P_{t2} \leq P_f \leq P_{f1}$) while the traveling drive pressure is low in order to engage the work vehicle, traveling at low speed with a low traveling operation pressure P_d (e.g., $P_{t1} \leq P_d \leq P_{d1}$), in heavy-load work. If, on the other hand, the boom is operated at a high traveling drive pressure condition, the bucking phenomenon does not occur as readily as at a low traveling drive pressure, and accordingly, the flow rate restriction control for restricting the flow rate of pressure oil to be delivered to the traveling motor 115 via the variable restrictor 161 is not executed in this situation. Through these measures, the drive force at the traveling motor 115 can be sustained at a sufficient level while the traveling drive pressure remains high.

[0081] The following variations are also within the scope of the present invention, and one of the variations or a plurality of the variations may be adopted in combination with any of the embodiments described above.

(Variations)

[0082]

(1) In the embodiments described above, the decision as to whether or not a work operation is currently underway is made based upon the secondary pilot pressure generated at the pilot valve at the boom operation lever 156 or the secondary pilot pressure generated at the pilot valve at the arm operation lever 157. However, the present invention is not limited to this example. The decision as to whether or not a work operation is currently underway may instead be made based upon the secondary pilot pressure generated at the pilot valve at the bucket operation lever.

(2) While the operation quantity at the boom operation lever 156 or the arm operation lever 157 is detected via the pressure sensor 172 in the embodiments described above, the present invention is not limited to this example. The pressure sensor 172 may instead be used to detect the operation quantity at the boom operation lever 156, the arm operation lever 157 or the bucket operation lever.

(3) In the embodiments described above, the pressure sensor 172 is utilized to detect a work operation and the pressure sensor 171 is utilized to detect a traveling operation. However, the present invention is not limited to this example and it may be adopted

to utilize, for instance, an angle sensor that detects the operational angle at an operation lever.

(4) The structures achieved in the embodiments described above include the traveling operation decision-making unit 121, the work operation decision-making unit 122 and the condition decision-making unit 180 and the flow rate restriction control is enabled when the flow rate restricting condition exists, whereas the flow rate restriction control is disabled if the flow rate restricting condition does not exist. However, the present invention is not limited to this example and it may instead be adopted in a structure that does not include the traveling operation decision-making unit 121, the work operation decision-making unit 122, the condition decision-making unit 180, the maximum value setting unit 182 or the switch unit 181.

(5) The various arithmetic operation units 123, 124, 125, 128, 129 and 384 in the embodiments described above may execute arithmetic operations based upon characteristics other than the characteristics f1 through f6 explained earlier. The opening area taking on the characteristics f1, f4, f5 or f6 may, for instance, increase linearly or in steps instead of manifesting an exponential increase. The opening area taking on the characteristics f2 or f3 may decrease linearly or in steps, instead of manifesting an exponential decrease.

(6) While the present invention is adopted in the wheel excavator 100 in the embodiments described above, the present invention is not limited to this example and it may be adopted in a traveling control device for any of various types of wheel-type work vehicles including a wheel loader and a forklift.

[0083] While the present invention has been described in reference to various embodiments and variations thereof, the present invention is in no way limited to the particulars of the embodiments and variations, and other aspects that are conceivable within the technical scope of the present invention are also within the scope of the invention.

[0084] The embodiments of the present invention and the variations thereof described above make it possible to reduce the severity of bucking or prevent bucking altogether when the work vehicle in a traveling state performs operation other than traveling operation. As a result, the operator in the wheel-type work vehicle is assured a comfortable ride.

Claims

1. A traveling control device for a wheeled work vehicle, comprising:

a hydraulic pump (130) driven by an engine (190);

a traveling motor (115) driven with pressure oil output from the hydraulic pump (130);

a work device actuator (116, 117) that is driven with pressure oil from the hydraulic pump (130) and drives a front work device;

a traveling directional control valve (145) via which a flow of pressure oil from the hydraulic pump (130) to the traveling motor (115) is controlled, and a work device directional control valve (146, 147) via which a flow of pressure oil from the hydraulic pump to the work device actuator is controlled, with the traveling directional control valve (145) and the work device directional control valve (146, 147) disposed on a center bypass line at the hydraulic pump (130); a flow control valve (161) disposed on an upstream side of the traveling directional control valve (145), that controls a flow rate of the pressure oil from the hydraulic pump (130) to the traveling motor (115);

a traveling operation member (155) operated to engage the traveling motor (115) in operation; a work operation member (156, 157) operated to engage the work device actuator (116, 117) in operation;

a traveling operation quantity detection means (171) for detecting a traveling operation quantity representing an extent of operation of the traveling operation member (155);

a work operation quantity detection means (172) for detecting a work operation quantity representing an extent of operation of the work operation member (156, 157);

an output pressure detection means (173) for detecting an output pressure of the hydraulic pump (130); and

a valve control means (120) for controlling the flow control valve (161) in correspondence to the traveling operation quantity detected by the traveling operation quantity detection means (171), the work operation quantity detected by the work operation quantity detection means (172) and the output pressure of the hydraulic pump detected by the output pressure detection means (173),

characterized in that:

the flow control valve (161) is a variable restrictor; and

the valve control means (120) controls the flow rate of pressure oil delivered to the traveling motor so as to deter bucking of the wheeled work vehicle if the wheeled work vehicle, currently in a traveling operation-only state in which the traveling operation member (155) is operated but the work operation member (156, 157) is not operated, shifts into a combination operation state in

which the traveling operation member (155) is operated and the work operation member (156, 157) is also operated, wherein

the valve control means (120) deters the bucking of the wheeled work vehicle when shifting from the traveling operation-only state into the combination operation state by controlling the flow control valve (161) so as to achieve a smaller opening area at the flow control valve (161) than the opening area achieved at the flow control valve (161) in the traveling operation-only state.

2. A traveling control device for a wheeled work vehicle according to claim 1, further comprising: a motor pressure detection means (374) for detecting a pressure of pressure oil delivered to the traveling motor (115), wherein: the valve control means (120) controls the flow control valve (161) by factoring in the pressure detected by the motor pressure detection means (374).

3. A traveling control device for a wheeled work vehicle according to any one of claims 1 through 2, further comprising:

a condition decision-making means (180) for determining that a flow rate restricting condition has been established when a traveling operation quantity equal to or greater than a predetermined value is detected by the traveling operation quantity detection means (171) and a work operation quantity equal to or greater than a predetermined value is detected by the work operation quantity detection means (172); and an enabling/disabling means for enabling the valve control means (120) to control the flow control valve (161) when the condition decision-making means (180) determines that the flow rate restricting condition has been established and disabling control of the flow control valve (161) by the valve control means (120) when the condition decision-making means (180) determines that the flow rate restricting condition has not been established.

4. A traveling control device for a wheeled work vehicle according to any one of claims 1 through 2, further comprising:

a reduction mechanism (150), capable of altering a reduction ratio, that slows down rotation of the traveling motor (155) and transmits the slowed rotation to wheels;
a reduction ratio detection means (283) for detecting the reduction ratio at the reduction mechanism (150);
a condition decision-making means (280) for de-

termining that a flow rate restricting condition has been established when a traveling operation quantity equal to or greater than a predetermined value is detected by the traveling operation quantity detection means (171), a work operation quantity equal to or greater than a predetermined value is detected by the work operation quantity detection means (172) and a reduction ratio equal to or greater than a predetermined value is detected by the reduction ratio detection means (283); and
an enabling/disabling means (181) for enabling the valve control means (120) to control the flow control valve (161) when the condition decision-making means (280) determines that the flow rate restricting condition has been established and disabling control of the flow control valve (161) by the valve control means (120) when the condition decision-making means (280) determines that the flow rate restricting means has not been established.

Patentansprüche

1. Fahrsteuervorrichtung für ein Radarbeitsfahrzeug, die Folgendes umfasst:

eine Hydraulikpumpe (130), die von einer Kraftmaschine (190) angetrieben wird;
einen Fahrmotor (115), der mit Drucköl, das von der Hydraulikpumpe (130) ausgegeben wird, angetrieben wird;
einen Arbeitsvorrichtungsaktor (116, 117), der mit Drucköl von der Hydraulikpumpe (130) angetrieben wird und eine vordere Arbeitsvorrichtung antreibt;
ein Fahrrichtungssteuerventil (145), über das ein Drucköldurchfluss von der Hydraulikpumpe (130) zu dem Fahrmotor (115) gesteuert wird, und ein Arbeitsvorrichtungsrichtungssteuerventil (146, 147), über das ein Drucköldurchfluss von der Hydraulikpumpe zu dem Arbeitsvorrichtungsaktor gesteuert wird, wobei das Fahrrichtungssteuerventil (145) und das Arbeitsvorrichtungsrichtungssteuerventil (146, 147) in einer zentralen Umgehungsleitung bei der Hydraulikpumpe (130) angeordnet sind;
ein Durchflussteuerventil (161), das auf einer stromaufwärts gelegenen Seite des Fahrrichtungssteuerventils (145) angeordnet ist und eine Durchflussmenge des Drucköls von der Hydraulikpumpe (130) zu dem Fahrmotor (115) steuert;
ein Fahrbetätigungselement (155), das betätigt wird, um den Fahrmotor (115) im Betrieb einzukuppeln;
ein Arbeitsbetätigungselement (156, 157), das

betätigt wird, um den Arbeitsvorrichtungsaktor (116,117) im Betrieb einzukuppeln;
 ein Fahrbetätigungsbetragsdetektionsmittel (171) zum Detektieren eines Fahrbetätigungsbetrags, der ein Ausmaß der Betätigung des Fahrbetätigungselements (155) repräsentiert;
 ein Arbeitsbetätigungsbetragsdetektionsmittel (172) zum Detektieren eines Arbeitsbetätigungsbetrags, der ein Ausmaß der Betätigung des Arbeitsbetätigungselements (156, 157) repräsentiert;
 ein Ausgabedruckdetektionsmittel (173) zum Detektieren eines Ausgabedrucks der Hydraulikpumpe (130); und
 ein Ventilsteuermittel (120) zum Steuern des Durchflussssteuerventils (161) in Übereinstimmung mit dem Fahrbetätigungsbetrag, der von dem Fahrbetätigungsbetragsdetektionsmittel (171) detektiert wird, dem Arbeitsbetätigungsbetrag, der von dem Arbeitsbetätigungsbetragsdetektionsmittel (172) detektiert wird, und dem Ausgabedruck der Hydraulikpumpe, der von dem Ausgabedruckdetektionsmittel (173) detektiert wird,

dadurch gekennzeichnet, dass

das Durchflussssteuerventil (161) ein veränderbarer Durchflussregulierer ist; und
 das Ventilsteuermittel (120) die Durchflussmenge von Drucköl steuert, das zu dem Fahrmotor geliefert wird, um ein Ruckeln des Radararbeitsfahrzeugs zu verhindern, wenn das Radararbeitsfahrzeug, das sich aktuell ausschließlich in einem Fahrbetriebszustand befindet, in dem das Fahrbetätigungselement (155) betrieben wird, aber das Arbeitsbetätigungselement (156,157) nicht betrieben wird, in einen kombinierten Betriebszustand umschaltet, in dem das Fahrbetätigungselement (155) betrieben wird und auch das Arbeitsbetätigungselement (156, 157) betrieben wird, wobei
 das Ventilsteuermittel (120) das Ruckeln des Radararbeitsfahrzeugs verhindert, wenn von dem ausschließlichen Fahrbetriebszustand in den kombinierten Betriebszustand umgeschaltet wird, indem es das Durchflussssteuerventil (161) steuert, um eine kleinere Öffnungsfläche bei dem Durchflussssteuerventil (161) zu erreichen, als die Öffnungsfläche, die bei dem Durchflussssteuerventil (161) in dem exklusiven Fahrbetriebszustand erreicht wird.

2. Fahrsteuervorrichtung für ein Radararbeitsfahrzeug nach Anspruch 1, die ferner Folgendes umfasst:

ein Motordruckdetektionsmittel (374) zum Detektieren eines Drucks von Drucköl, das zu dem Fahrmotor (115) geliefert wird, wobei
 das Ventilsteuermittel (120) das Durchfluss-

steuerventil (161) unter Berücksichtigung des von dem Motordruckdetektionsmittel (374) detektierten Drucks steuert.

3. Fahrsteuervorrichtung für ein Radararbeitsfahrzeug nach einem der Ansprüche 1 bis 2, die ferner Folgendes umfasst:

ein Zustandsentscheidungsfindungsmittel (180) zum Bestimmen, dass eine Durchflussbetragsbeschränkungsbedingung festgelegt wurde, wenn ein Fahrbetätigungsbetrag, der gleich oder größer als ein vorbestimmter Wert ist, von dem Fahrbetätigungsbetragsdetektionsmittel (171) detektiert wird und ein Arbeitsbetätigungsbetrag, der gleich oder größer als ein vorbestimmter Wert ist, von dem Arbeitsbetätigungsbetragsdetektionsmittel (172) detektiert wird; und
 ein Aktivierungs-/Deaktivierungsmittel zum Aktivieren des Ventilsteuermittels (120), um das Durchflussssteuerventil (161) zu steuern, wenn das Zustandsentscheidungsfindungsmittel (180) bestimmt, dass die Durchflussbetragsbeschränkungsbedingung festgelegt wurde, und zum Deaktivieren der Steuerung des Durchflussssteuerventils (161) durch das Ventilsteuermittel (120), wenn das Zustandsentscheidungsfindungsmittel (180) bestimmt, dass die Durchflussbetragsbeschränkungsbedingung nicht festgelegt wurde.

4. Fahrsteuervorrichtung für ein Radararbeitsfahrzeug nach einem der Ansprüche 1 bis 2, die ferner Folgendes umfasst:

einen Untersetzungsmechanismus (150), der in der Lage ist, ein Untersetzungsverhältnis zu ändern, der die Drehung des Fahrmotors (155) verlangsamt und die verlangsamte Drehung auf Räder überträgt;
 ein Untersetzungsverhältnisdetektionsmittel (283) zum Detektieren des Untersetzungsverhältnisses an dem Untersetzungsmechanismus (150);
 ein Zustandsentscheidungsfindungsmittel (280) zum Bestimmen, dass eine Durchflussbetragsbeschränkungsbedingung festgelegt wurde, wenn ein Fahrbetätigungsbetrag, der gleich oder größer als ein vorbestimmter Wert ist, von dem Fahrbetätigungsbetragsdetektionsmittel (171) detektiert wird und ein Arbeitsbetätigungsbetrag, der gleich oder größer als ein vorbestimmter Wert ist, von dem Arbeitsbetätigungsbetragsdetektionsmittel (172) detektiert wird und ein Untersetzungsverhältnis, das gleich oder größer als ein vorbestimmter Wert ist, von dem Untersetzungsverhältnisdetektionsmittel

(283) detektiert wird; und
 ein Aktivierungs-/Deaktivierungsmittel (181)
 zum Aktivieren des Ventilsteuermittels (120),
 um das Durchflusssteuerventil (161) zu steuern,
 wenn das Zustandsentscheidungsfindungsmit- 5
 tel (280) bestimmt, dass die Durchflussbetrags-
 beschränkungsbedingung festgelegt wurde,
 und zum Deaktivieren der Steuerung des Durch-
 flusssteuerventils (161) durch das Ventilsteuer- 10
 mittel (120), wenn das Zustandsentscheidungs-
 findungsmittel (280) bestimmt, dass die
 Durchflussbetragsbeschränkungsbedingung
 nicht festgelegt wurde.

Revendications

1. Dispositif de commande de déplacement pour un véhicule de chantier sur roues, comprenant :

une pompe hydraulique (130) entraînée par un 20
 moteur (190) ;
 un moteur de déplacement (115) entraîné avec
 de l'huile sous pression refoulée par la pompe
 hydraulique (130) ; 25
 un actionneur pour dispositif de travail (116,
 117) qui est entraîné avec l'huile sous pression
 provenant de la pompe hydraulique (130) et qui
 entraîne un dispositif de travail avant ;
 une valve de commande directionnelle de dé- 30
 placement (145) via laquelle un flux d'huile sous
 pression provenant de la pompe hydraulique
 (130) vers le moteur de déplacement (115) est
 commandé, et une valve de commande direc- 35
 tionnelle de dispositif de travail (146, 147) via
 laquelle un flux d'huile sous pression provenant
 de la pompe hydraulique vers l'actionneur pour
 dispositif de travail est commandé, la valve de
 commande directionnelle de déplacement (145) 40
 et la valve de commande directionnelle du dis-
 positif de travail (146, 147) étant disposées sur
 un conduit de by-pass central au niveau de la
 pompe hydraulique (130) ;
 une valve de commande d'écoulement (161) 45
 disposée sur un côté amont de la valve de com-
 mande directionnelle de déplacement (145), qui
 commande un débit d'huile sous pression pro-
 venant de la pompe hydraulique (130) vers le
 moteur de déplacement (115) ;
 un élément de fonctionnement de déplacement 50
 (155) dont la fonction est d'engager le moteur
 de déplacement (115) en fonctionnement ;
 un élément de fonctionnement de travail (156,
 157) dont la fonction est d'engager l'actionneur
 du dispositif de travail (116, 117) en 55
 fonctionnement ;
 un moyen de détection de quantité de fonction-
 nement de déplacement (171) pour détecter une

quantité de fonctionnement de déplacement re-
 présentant une étendue du fonctionnement de
 l'élément de fonctionnement de déplacement
 (155) ;

un moyen de détection de quantité de fonction-
 nement de travail (172) pour détecter une quan-
 tité de fonctionnement de travail représentant
 une étendue du fonctionnement de l'élément de
 fonctionnement de travail (156, 157) ;

un moyen de détection de pression de refoule-
 ment (173) pour détecter une pression de refou-
 lement de la pompe hydraulique (130) ; et

un moyen de commande de valve (120) pour
 commander la valve de commande d'écoule-
 ment (161) en correspondance de la quantité de
 fonctionnement de déplacement détectée par le
 moyen de détection de quantité de fonctionne-
 ment de déplacement (171), la quantité de fonc-
 tionnement de travail détectée par le moyen de
 détection de quantité de fonctionnement de tra-
 vail (172) et la pression de sortie de la pompe
 hydraulique détectée par le moyen de détection
 de pression de refoulement (173),

caractérisé en ce que :

la valve de commande d'écoulement (161)
 est une restriction variable ; et

le moyen de commande de valve (120)
 commande le débit d'huile sous pression
 fournie au moteur de déplacement de ma-
 nière à empêcher un cabrage du véhicule
 de chantier sur roues si le véhicule de chan-
 tier sur roues, actuellement dans un état de
 fonctionnement de déplacement unique-
 ment dans lequel l'élément de fonctionne-
 ment de déplacement (155) est en fonction-
 nement mais que l'élément de fonctionne-
 ment de travail (156, 157) n'est pas en fonc-
 tionnement, commute vers un état de fonc-
 tionnement combiné dans lequel l'élément
 de fonctionnement de déplacement (155)
 est en fonctionnement et l'élément de fonc-
 tionnement de travail (156, 157) est égale-
 ment en fonctionnement, dans lequel

le moyen de commande de valve (120) empê-
 che un cabrage du véhicule de chantier sur
 roues lorsqu'il commute depuis l'état de fonc-
 tionnement de déplacement uniquement vers
 l'état de fonctionnement combiné en comman-
 dant la valve de commande d'écoulement (161)
 de manière à réaliser une superficie d'ouverture
 plus petite au niveau de la valve de commande
 d'écoulement (161) que la superficie d'ouvertu-
 re atteinte au niveau de la valve de commande
 d'écoulement (161) dans l'état du fonctionne-
 ment de déplacement uniquement.

2. Dispositif de commande de déplacement pour un véhicule de chantier sur roues selon la revendication 1, comprenant en outre :
 un moyen de détection de pression moteur (374) pour détecter une pression de l'huile sous pression fournie au moteur de déplacement (115), dans lequel :
 le moyen de commande de valve (120) commande la valve de commande d'écoulement (161) en tenant compte de la pression détectée par le moyen de détection de pression moteur (374). 5
3. Dispositif de commande de déplacement pour un véhicule de chantier sur roues selon l'une des revendications 1 et 2, comprenant en outre : 10
- un moyen de prise de décision de condition (180) pour déterminer qu'une condition de restriction du débit a été établie quand une quantité de fonctionnement de déplacement égale ou supérieure à une valeur prédéterminée est détectée par le moyen de détection de quantité de fonctionnement de déplacement (171) et qu'une quantité de fonctionnement de travail égale ou supérieure à une valeur prédéterminée est détectée par le moyen de détection de quantité de fonctionnement de travail (172) ; et 20
- un moyen d'activation/désactivation pour activer le moyen de commande de valve (120) et commander la valve de commande d'écoulement (161) quand le moyen de prise de décision de condition (180) détermine que la condition de restriction du débit a été établie et pour désactiver la commande de la valve de commande d'écoulement (161) par le moyen de commande de valve (120) quand le moyen de prise de décision de condition (180) détermine que la condition de restriction de débit n'a pas été établie. 25 30 35
4. Dispositif de commande de déplacement pour un véhicule de chantier sur roues selon l'une quelconque des revendications 1 et 2, comprenant en outre : 40
- un mécanisme de réduction (150), capable de modifier un rapport de réduction, qui ralentit la rotation du moteur de déplacement (155) et qui transmet aux roues la rotation ralentie ; 45
- un moyen de détection de rapport de réduction (283) pour détecter le rapport de réduction au niveau du mécanisme de réduction (150) ; 50
- un moyen de prise de décision de condition (280) pour déterminer qu'une condition de restriction de débit a été établie quand une quantité de fonctionnement de déplacement égale ou supérieure à une valeur prédéterminée est détectée par le moyen de détection de quantité de fonctionnement de déplacement (171), une quantité de fonctionnement de travail égale ou 55

supérieure à une valeur prédéterminée est détectée par le moyen de détection de quantité de fonctionnement de travail (172), et un rapport de réduction égal ou supérieur à une valeur prédéterminée est détecté par le moyen de détection de rapport de réduction (283) ; et
 un moyen d'activation/désactivation (181) pour activer le moyen de commande de valve (120) et commander la valve de commande d'écoulement (161) quand le moyen de prise de décision de condition (280) détermine que la condition de restriction du débit a été établie et pour désactiver la commande de la valve de commande d'écoulement (161) par le moyen de commande de valve (120) quand le moyen de prise de décision de condition (280) détermine que la condition de restriction du débit n'a pas été établie.

FIG.1

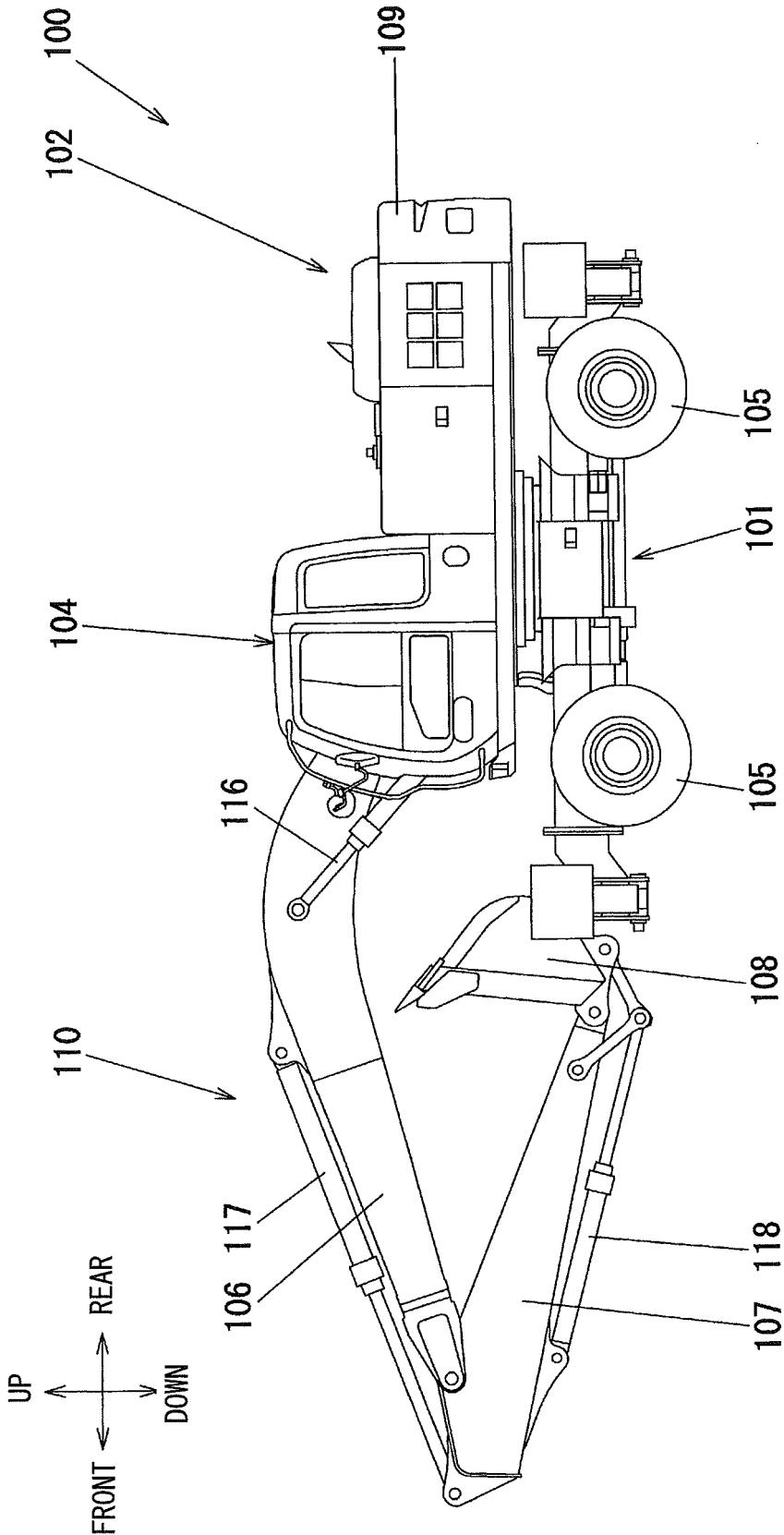


FIG. 2

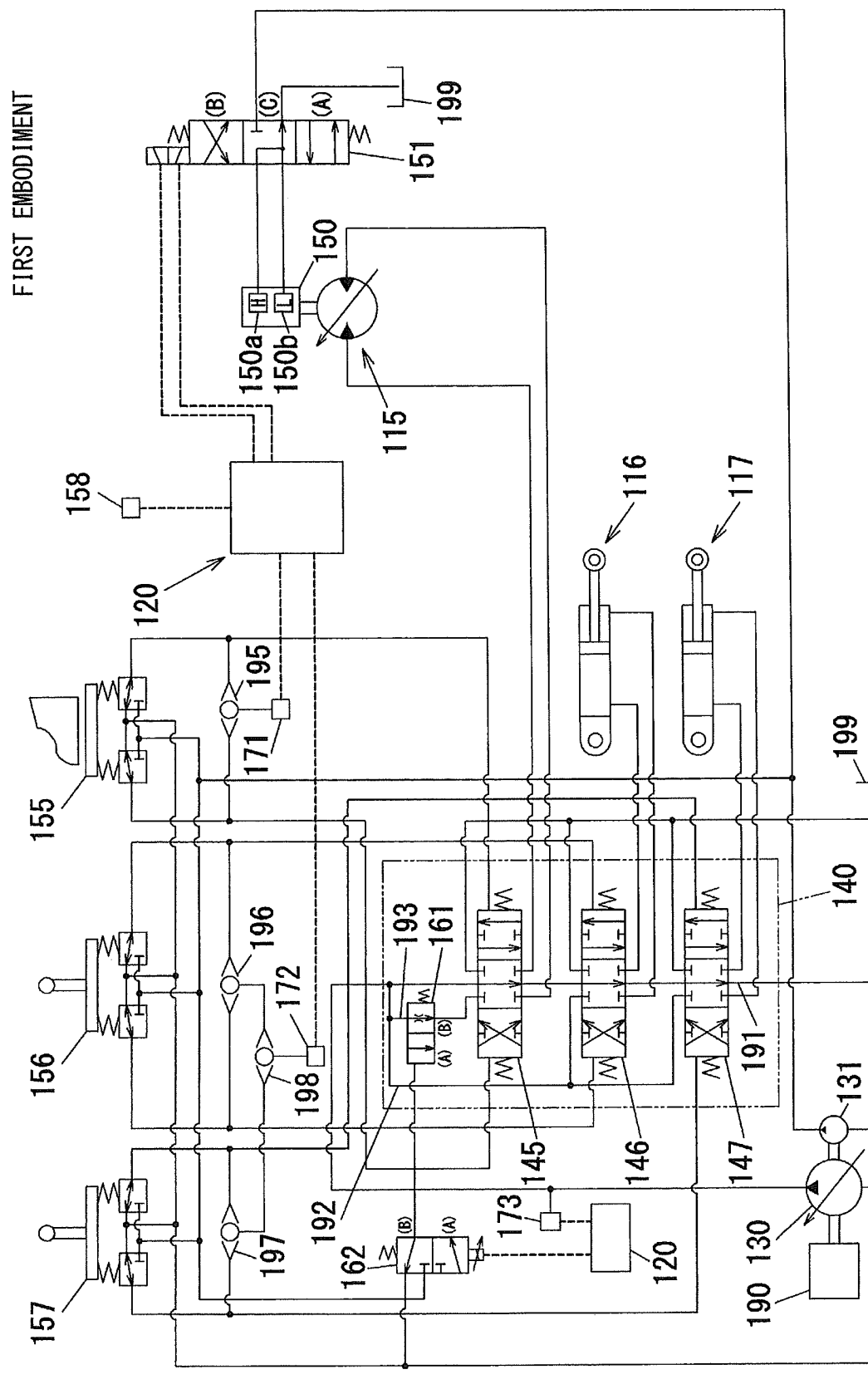


FIG.3

FIRST EMBODIMENT

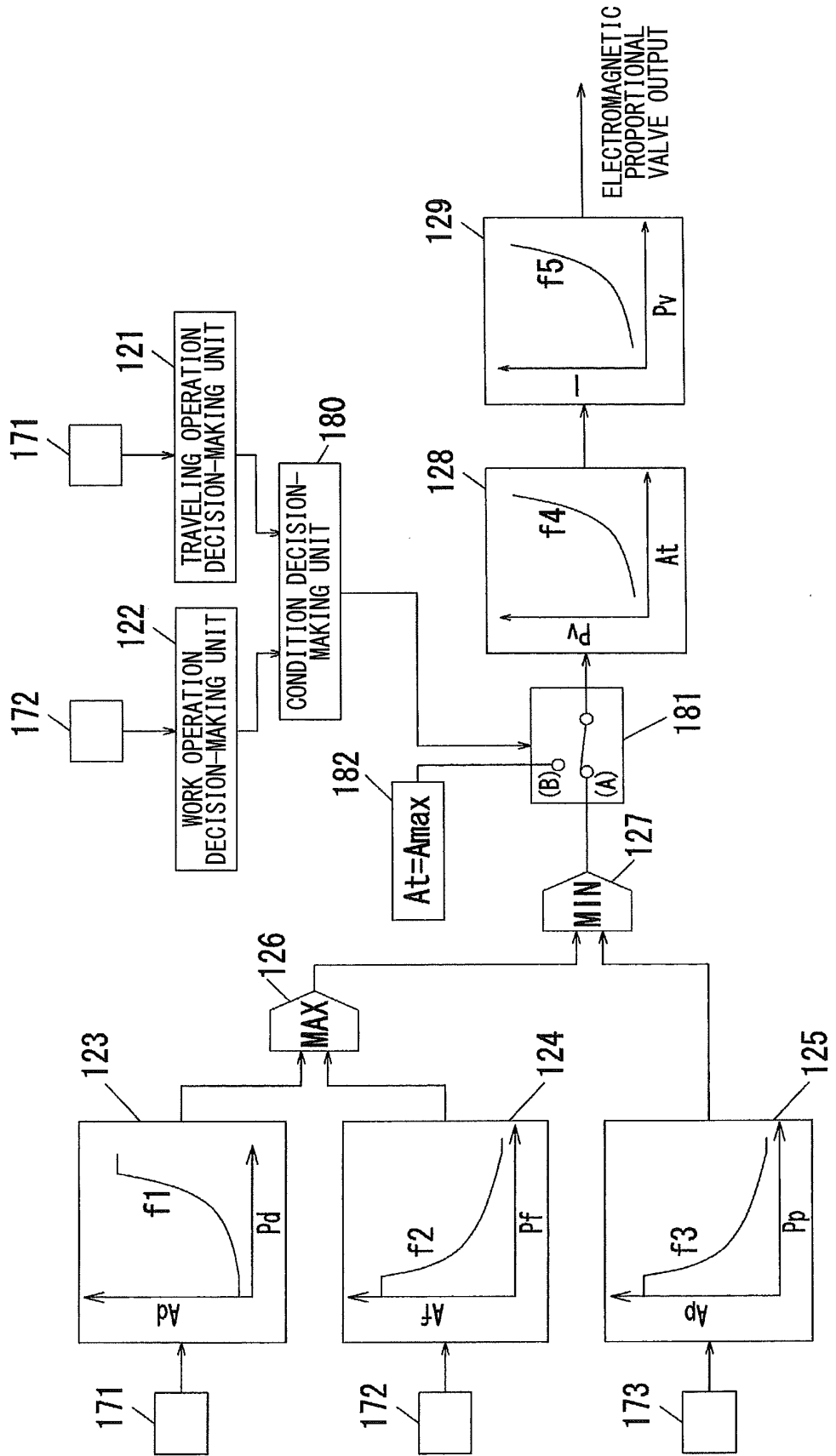


FIG.4A

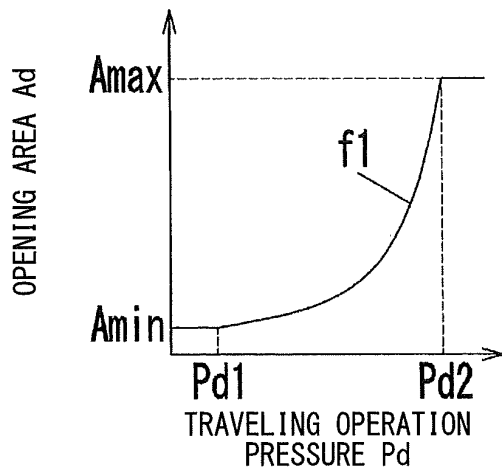


FIG.4D

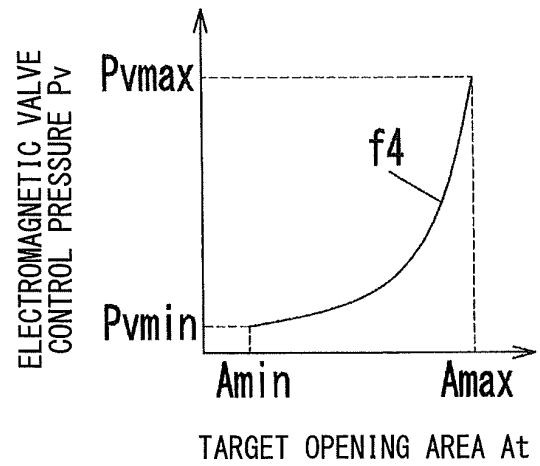


FIG.4B

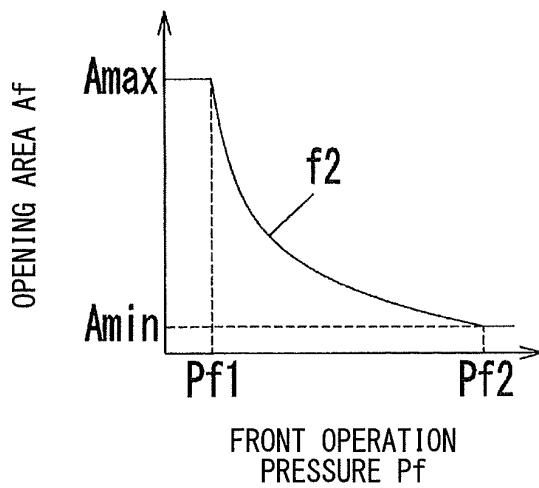


FIG.4E

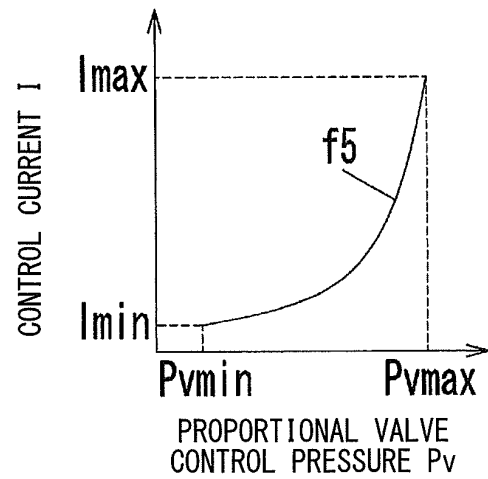


FIG.4C

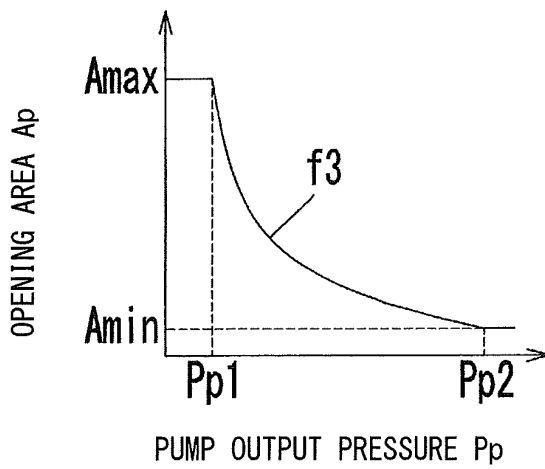


FIG.5

SECOND EMBODIMENT

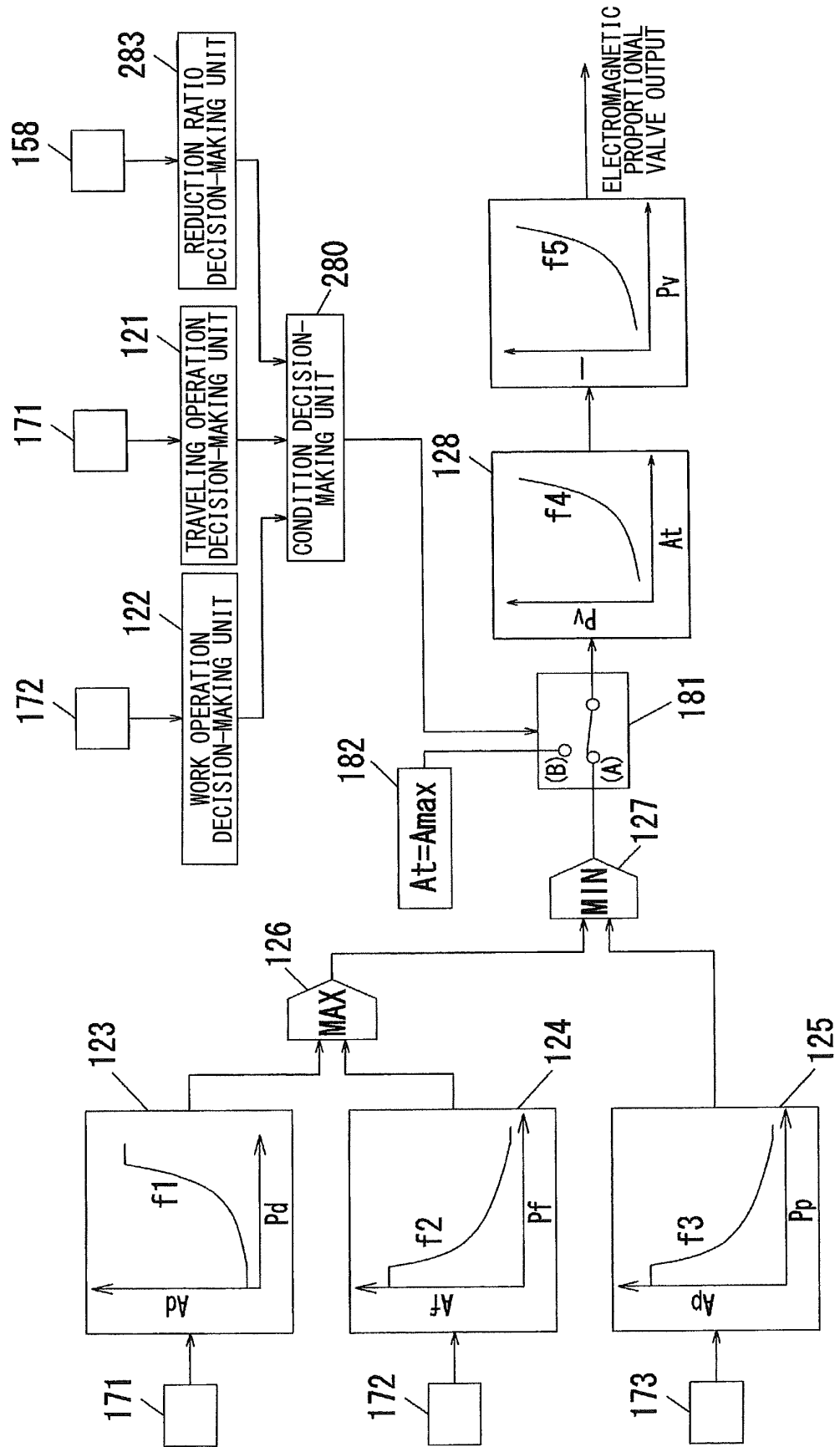


FIG.6

THIRD EMBODIMENT

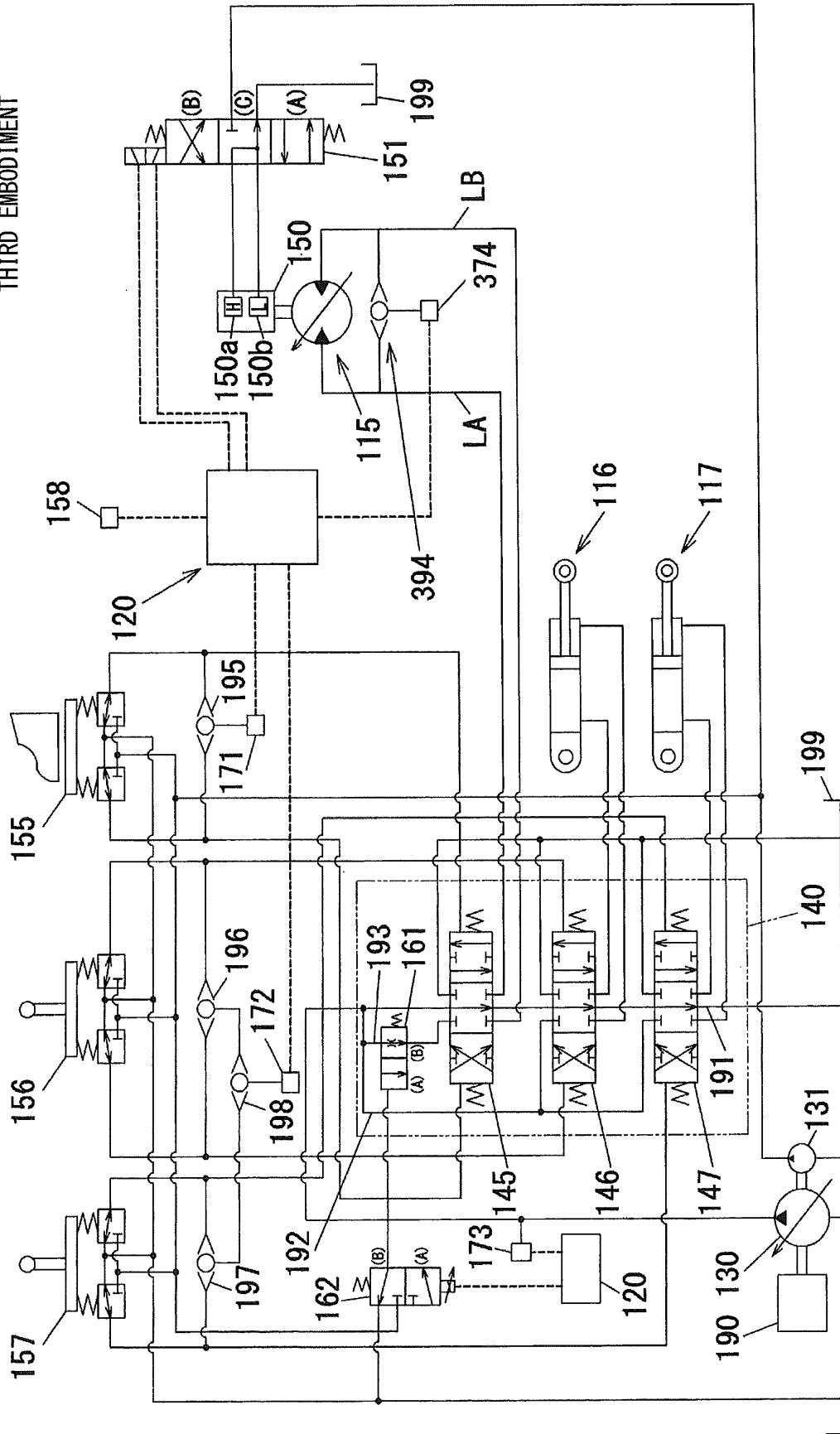


FIG.7

THIRD EMBODIMENT

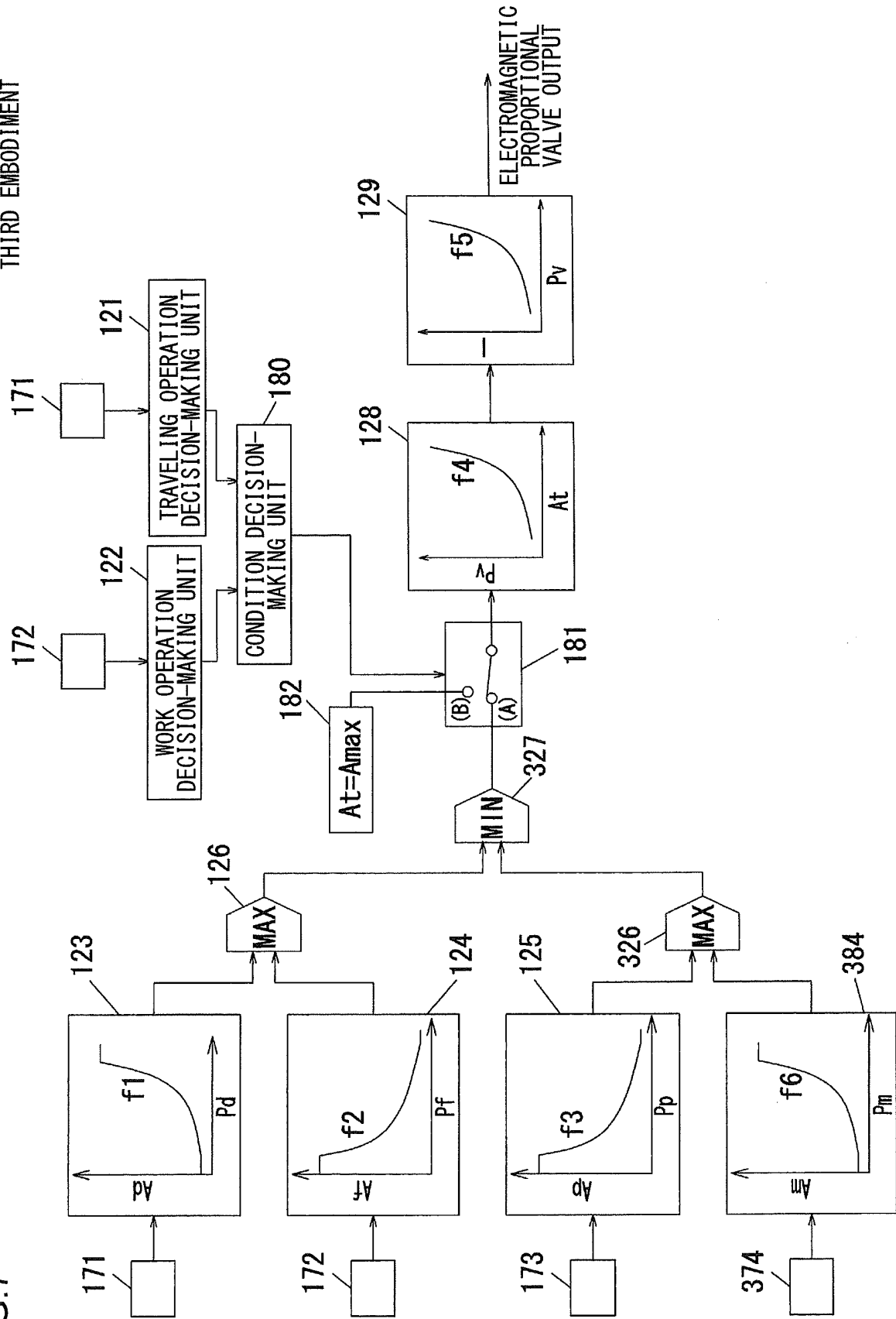
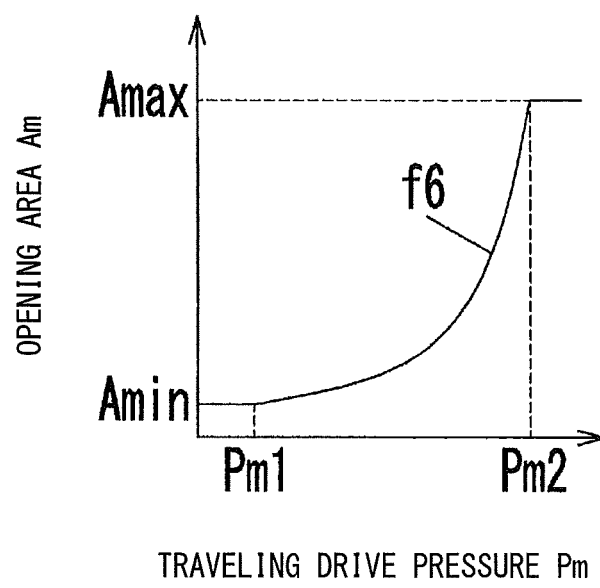


FIG.8



REFERENCES CITED IN THE DESCRIPTION

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