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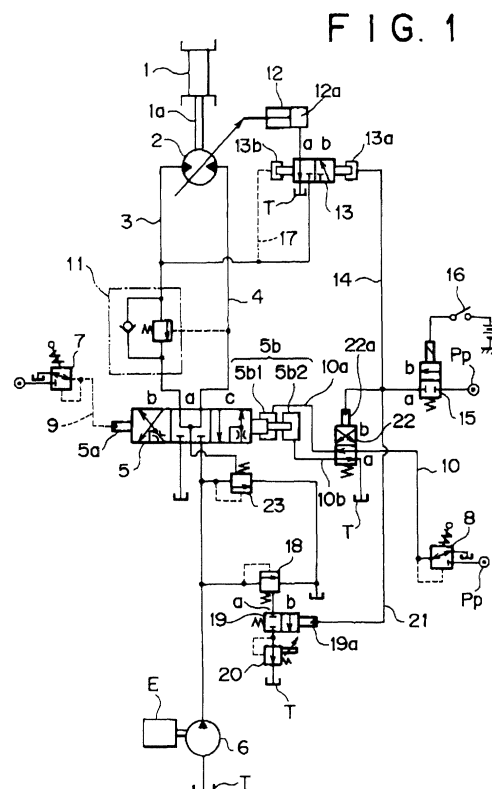
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(54) **Control device for hydraulic drive winch**

(57) A winding-down side pilot port (5b) of a control valve (5) is of a 2-port construction comprising a normal winding-down side port (5b1) having a large pressure receiving area and a free fall side port (5b2) having a small pressure receiving area, wherein in the free fall operation carried out by setting a motor (2) to a small capacity, a pilot pressure of a winding-down side remote control valve (8) is supplied to the free fall side port through a mode switching valve (22). Thereby, a stroke of the control valve (5) can be suppressed so that a speed of a motor (2) does not exceed an allowable speed.

Additionally a load holding hydraulic system is disclosed with a hydraulic motor (101) and bidirectional pump (104) in closed circuit.



Description

BACKGROUND OF THE INVENTION

(FIELD OF THE INVENTION)

[0001] The present invention relates to a control device for a hydraulic drive winch for controlling rotation of a winch drum driven by a hydraulic motor.

(DESCRIPTION OF THE RELATED ART)

[0002] A conventional control device for a hydraulic drive winch is shown in Japanese Patent Application Laid-Open No. 63-35555 Publication. That is, in the aforesaid device, a winch drum is provided with a clutch, and both negative and positive brakes. These clutch and brakes are on/off controlled according to the operating conditions of drum drive and stop, and free fall (free fall of suspended load). For the free fall, the clutch, the positive brake and a control system for them are necessary. This poses a problem that the device constitution becomes complicated, and the cost is high.

[0003] So, we have proposed a device for eliminating the clutch and brakes for the free fall. This device is shown in Japanese Patent Application Laid-Open No. Hei 11-79679 Publication. By setting a motor to a small capacity during the free fall operation, the winch drum can be wound down and rotated at high speeds.

[0004] Incidentally, a hydraulic pump, which is a hydraulic source for a hydraulic motor, is not exclusively used for a winch but is used in common as a hydraulic source for a plurality of actuators. Therefore, the engine speed is changed by the total of loads of the actuators. The pump flow rate is changed by the change of the engine speed. The motor flow rate is changed accordingly. The motor flow rate is changed at a position of the same control valve during the free fall operation. Therefore, when the engine speed is risen, the motor speed exceeds the allowable speed so that there sometimes possibly occurs the situations such that the winding-down speed is excessively high, and the random winding occurs.

[0005] As the winding-down operating means for operating the control valve on the winding-down side, the present inventors have provided, separately from the first winding-down operating means for normal winding-down, the second winding-down operating means for free fall operation. The second winding-down operating means controls the passage flow rate of the control valve so that the flow rate of the hydraulic motor does not exceed the allowable flow rate at the minimum valve of the motor capacity. The passage flow rate of the valve (motor flow rate) is controlled by operating the control valve by the second winding-down operating means during the free fall operation.

[0006] Accordingly, the excessive rotation can be prevented while keeping the motor flow rate properly.

[0007] In this case, as the winding-down operating means, there are two operating means, i.e., normal winding-down and free fall operation. Therefore, in the operation for continuously carrying out the winding-up operation and the free fall operation, the operation becomes complicated.

[0008] Further, where the winch drum is wound down and rotated at high speeds by setting the motor to a small capacity during the free fall operation, the speed when winding-down starts becomes quick as the load of a hanging load increases. Where a rapid lever operation is carried out, a shock possibly occurs in the vehicle body. Furthermore, when the initial speed is high, the movement of a counter balance valve cannot follow the hanging load, and hunting possibly occurs.

SUMMARY OF THE INVENTION

[0009] It is a first object of the present invention to provide a control device for a hydraulic drive winch capable of preventing excessive speed of a motor caused by an increase in engine speed during the free fall operation and capable of using winding-down operating means for normal winding-down operation and free fall operation in common.

[0010] It is a second object of the present invention to provide a control device for a hydraulic drive winch occurring no shock at the time of starting winding-down because initial speed is low even where a load of a hanging load is heavy and also capable of preventing occurrence of hunting.

[0011] The control device for a hydraulic drive winch according to the present invention has the following fundamental constitution. That is, the control device comprises a winch drum, a variable capacity type hydraulic motor for driving the winch drum, a hydraulic pump as a hydraulic source, a control valve for controlling supply and discharge of pressure oil to the hydraulic motor, winding-up side for operating the control valve on the winding-up operating means, motor capacity control means for controlling capacity of the hydraulic motor, and free fall instructing means for outputting free fall instructions. The motor capacity control means is operated on the basis of the free fall instructions from the free fall instructing means to set the hydraulic motor to a small capacity, in which state the winding-down operating means is operated whereby the winch drum is wound down and rotated at high speeds to carry out the free fall operation.

[0012] In this case, looseness of a rope and random winding can be prevented.

[0013] Preferably, control valve controlling means is provided in addition to the above-described fundamental constitution. The control valve controlling means controls an opening degree of the control valve relative to the operating amount of the winding-down operating means to be smaller than that of the normal winding-down operation without the free fall instructions so that

at the time of the free fall operation, the supply flow rate to the hydraulic motor is less than the allowable flow rate of the hydraulic motor.

[0014] In this case, at the time of the free fall operation, an opening degree (passage flow rate) of the control valve with respect to the operating amount of the winding-down operating means is throttled. Thereby, the excessive speed of the motor at the time of the free fall operation can be prevented. Accordingly, it is possible to prevent the random winding from occurrence.

[0015] In the control device for a hydraulic drive winch according to the present invention, alternatively, the motor capacity control means in the above-described fundamental constitution may employ the following constitution. In this motor capacity control means, the motor capacity is increased on the high engine speed side according to the engine speed for driving the hydraulic pump, whereby at the time of the free fall operation, the hydraulic motor speed is controlled to no more than the allowable speed of the hydraulic motor.

[0016] In this case, the motor capacity increase as the engine speed rises. Accordingly, it is possible to prevent the excessive speed of the motor at the time of the free fall operation.

[0017] The control device for a hydraulic drive winch may comprise, in addition to the above-described fundamental constitution, free fall control means. The free fall control means changes the capacity of the hydraulic motor from a large capacity to a small capacity in proportional to the operating amount of the winding-down operating means.

[0018] In this case, when the free fall operation is selected by the free fall instructing means, a tilting angle of the variable capacity motor is controlled, for example. Thereby, the capacity of the variable capacity motor is set from a large capacity to a small capacity in proportional to the winding-down operating amount. So, when the winding-down operation is carried out using the operating means which is common in operation to the free fall operation, the initial speed of the free fall gets slow since at the time of starting free fall operation, the capacity of the variable capacity motor is large. Accordingly, the free fall operation can be carried out safely.

[0019] Further, in a closed circuit, a control device for a hydraulic winch to enable free fall operation has the following constitutions:

[0020] A winch drum. A hydraulic motor for driving the winch drum. A hydraulic pump as a hydraulic source for the hydraulic motor, the hydraulic pump and the hydraulic motor being connected by the closed circuit. Further, a motor speed switching means for switching modes between a high speed rotation mode for winding-down rotating the hydraulic motor at relatively high speeds and a low speed rotation mode for winding-down rotating the hydraulic motor at relatively low speeds. A winding-down operation means for outputting a winding-down instruction signal. A pump control means for controlling a discharge direction and a discharge flow rate of the hy-

draulic pump. The pump control means is constituted so that in the state that the motor speed switching means is set to the high speed rotation mode and the winding-down operation means is winding-down operated, when a winding-down side holding pressure of the closed circuit is lowered to a level below a set value of winding-down stop, the rotation of the hydraulic motor stops to control the hydraulic pump in the direction of stopping the winding-down operation.

[0021] In this case, it is possible to obtain a winding-down automatic stopping action when in landing which constitutes the condition of the free fall operation as well as the high speed winding down. That is, the free fall operation can be realized even in the closed circuit.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022]

FIG. 1 is a circuit constituent view showing Example 1 of the present invention;

FIG. 2 is a view showing a relationship between pilot pressure from a remote control valve and a stroke of a control valve in Example 1;

FIG. 3 is a view showing a relationship between the stroke of a control valve and a passage flow rate of the valve in Example 1;

FIG. 4 is a view showing a relationship between engine speed and pump flow rate in Example 1;

FIG. 5 is a view showing a relationship between engine speed and motor flow rate in Example 1;

FIG. 6 is a circuit constituent view showing Example 2 of the present invention;

FIG. 7 is a circuit constituent view showing Example 3 of the present invention;

FIG. 8 is a view showing a relationship between a remote control valve operating amount and pilot pressure in Example 3;

FIG. 9 is a view showing a relationship between remote control valve pilot pressure and a stroke of a control valve in Example 3;

FIG. 10 is a circuit constituent view showing Example 4 of the present invention;

FIG. 11 is a circuit constituent view showing Example 5 of the present invention;

FIG. 12 is a view showing a relationship between engine speed (pump flow rate) and an input current of an electromagnetic proportional reduction valve in Example 5;

FIG. 13 is a view showing a relationship between engine speed and motor capacity in Example 5;

FIG. 14 is a view showing a relationship between engine speed and motor speed in Example 1;

FIG. 15 is a circuit constituent view showing Example 6 of the present invention;

FIG. 16 is a graph showing a relationship between pilot pressure and motor capacity in Example 6;

FIG. 17A is a graph showing a lever operating

amount in Example 6, and FIG. 17B is a graph for comparing winch drum speed and that of prior art; FIG. 18 is a circuit constituent view showing Example 7 of the present invention; FIG. 19 is a circuit constituent view showing Example 8 of the present invention; FIG. 20 is a graph showing a relationship between remote control pressure and relief pressure in Example 8. FIG. 21 is a circuit constituent view showing Example 9 of the present invention; FIG. 22 is a view showing the range in which a winding-down operation stops, the range being determined by the winding-down instruction pressure and the winding-down side holding pressure in Example 9; FIG. 23 is a view showing a relationship between the winding-down instruction pressure and the pump discharge flow rate in Example 9; FIG. 24 is a circuit constituent view showing Example 10 of the present invention; FIG. 25 is a circuit constituent view showing Example 11 of the present invention; and FIG. 26 is a circuit constituent view showing Example 12 of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0023] The forms of embodiments of the present invention will be described with reference to FIGS. 1 to 26.

(A) First, a first form of embodiment will be described hereinafter on the basis of Examples 1 to 5.

EXAMPLE 1 (See FIGS. 1 to 5)

[0024] Reference numeral 1 denotes a winch drum. A rotational shaft 1a of the winch drum 1 is connected directly or through a reduction unit to a hydraulic motor 2 for a winch of a variable capacity type. The winch drum 1 is rotated and driven by the motor 2.

[0025] Both winding-up and winding-down pipes 3, 4 constituting a driving circuit of the hydraulic motor 2 are connected to a hydraulic pump 6 through a hydraulic pilot switching type control valve 5 provided with three positions a, b and c, i.e., neutral, winding-up and winding-down. Supply and discharge (drive, stop, and rotating direction and speed at the time of drive) of pressure oil to the motor is controlled by the control valve 5.

[0026] Reference numeral 7 denotes a winding-up side remote control valve as winding-up operating means for operating the control valve 5 on the winding-up side. Reference numeral 8 denotes a winding-down side remote control valve as winding-down operating means for operating the control valve 5 on the winding-down side at the time of power winding-down. Pilot pressure according to the operating amount of both the re-

mote control valves 7, 8 is fed to both pilot ports 5a, 5b on the winding-up side and winding-down side of the control valve 5.

[0027] The both the remote control valves 7, 8 on the winding-up side and the winding-down side, normally, are integrally formed and selectively operated by a single lever.

[0028] Reference numeral 11 denotes a counter-balance valve as a brake valve for generating a hydraulic brake force in the winding side pipe 3 at the time of power winding-down rotation. Reference character E denotes an engine for driving the hydraulic pump 6.

[0029] Motor capacity control means for controlling capacity of the hydraulic motor 2 will be described.

[0030] Reference numeral 12 denotes a cylinder (hereinafter referred to as a capacity regulating cylinder) as a motor capacity regulating actuator for changing a tilting angle of the hydraulic motor 2 to thereby change the motor capacity. The hydraulic motor 2 is set to a large capacity in a state that the cylinder 12 is contracted, and set to a small capacity in a state that the cylinder is extended.

[0031] An oil chamber 12a on the contracted side of the capacity regulating cylinder 12 is connected to the winding-up side pipe 3 through a cylinder control valve (an actuator control valve) 13 of a hydraulic pilot switching type.

[0032] The cylinder control valve 13 has a large capacity position (a) and a small capacity position (b). At the large capacity position (a), an oil chamber 12a on the extended side of the cylinder is communicated with a tank T so that the capacity regulating cylinder 12 is contracted (the hydraulic motor 2 is set to a large capacity).

[0033] On the other hand, when the control valve 13 is switched to the small capacity position (b), oil in the winding-up side pipe 3 is introduced into the oil chamber 12a on the extended side of the cylinder whereby the cylinder 12 is extended (the hydraulic motor 2 is set to a small capacity region).

[0034] A small capacity pilot port 13a of the cylinder control valve 13 is connected to an output port of a free fall valve (an electromagnetic switching valve) 15 as free fall instruction means through a motor capacity switching line 14.

[0035] The free fall valve 15 is set to a non-operation position (a) shown in FIG. 1 at the time of normal operation except the free fall operation. In this state, the cylinder control valve 13 is maintained at a large capacity position (a) shown.

[0036] When from that position, the free fall switch 16 is operated, the free fall valve 15 is switched to the operating position (b). Thereby, oil pressure of a pilot hydraulic source Pp is supplied to the small capacity side pilot port 13a of the cylinder control valve 13 so that the control valve 13 is switched to a small capacity position (b). Accordingly, the capacity regulating cylinder 12 is operated to be extended, and the hydraulic motor 2 is

set to a small capacity.

[0037] On the other hand, the large capacity side pilot port 13b of the cylinder control valve 13 is connected to the winding-up side pipe 3 by a winding-up side pressure detecting line 17. When the pressure of the pipe 3 rises, the cylinder control valve 13 is operated with respect to the large capacity position (a) side so that the motor capacity increases.

[0038] In the following, the pump pressure control means for setting pump pressure to a low level at the time of free fall operation will be described.

[0039] Reference numeral 18 denotes a variable relief valve as pump pressure setting means for setting pump pressure. To a spring side pressure port of the relief valve 18 are directly connected a pump pressure-switching valve 19 of a hydraulic pilot type, and a pump pressure setting valve 20. The pump pressure-switching valve 19 is switched to a closed position (a) and an open position (b), vice versa.

[0040] A pilot port 19a of the pump pressure-switching valve 19 is connected to a pump pressure control line 21. The pump pressure control line 21 is connected to an output port of the free fall valve 15.

[0041] Next, when the free fall valve 15 is set to an operating position (b), oil pressure from the pilot hydraulic source Pp is supplied to the pilot port 19a. Then, the switching valve 19 is switched from the closed position (a) to the open position (b).

[0042] Thereby, set pressure of the relief valve 18, that is, pump pressure is set to a value determined by set pressure of the pump pressure setting valve 20.

[0043] The pump pressure determined by the pump pressure setting valve 20 is set to a value at which a relationship between the pump pressure and the winding-down rotating force > drum rotating resistance is established.

[0044] In the foregoing constitution, at the time of normal winding-up and winding-down operation, the free fall valve 15 is set to a non-operation position (a).

[0045] In this state, the motor capacity and the pump pressure are set to a large capacity and a high pressure, respectively. The hydraulic motor 2 is driven at a speed corresponding to the operating amount (stroke of the control valve 5) of both winding-up side and winding-down side remote control valves 7, 8, and normal winding-up and winding-down operation are carried out.

[0046] Then, when the free fall operation is carried out, the free fall switch 16 is operated to switch the free fall valve 15 to the operation position (b).

[0047] When in that state, the winding-down side remote control valve 8 is operated, the motor capacity and the pump pressure are set to a small capacity and a low pressure, respectively. Thereby, the hydraulic motor 2 is wound down and driven at high speeds to effect the free fall operation.

[0048] At this time, an opening degree of the control valve 5 is changed according to the operating amount of the winding-down side remote control valve 8 to

change the motor capacity. Therefore, the free fall speed can be adjusted or stopped by the remote control valve 8.

[0049] In the above-described manner, the motor capacity can be set to a small capacity to thereby wind down and drive the hydraulic motor 2 at high speeds to obtain the free fall function. Therefore, a clutch and a positive brake for the free fall, and a control system therefor are eliminated.

[0050] Further, since the pump pressure is set to low pressure simultaneously, the motor speed will not be excessively high. Therefore, it is possible to carry out operation near the original free fall, which is free from looseness of a rope and random winding.

[0051] On the other hand, the hydraulic pump 6 is not exclusively used for the hydraulic motor 2 for a winch, as described above, but is used in common as the hydraulic source for one or more actuators not shown. Because of this, engine speed changes with variation of the total load. The pump flow rate is changed by the change of engine speed to change the motor flow rate. Therefore, excessive speed of the motor 2 possibly occurs.

[0052] A countermeasure on the above point will be described below.

[0053] The winding-down side pilot port 5b of the control valve 5 is of a 2-port construction comprising a normal winding-down side port 5b1 having a relatively large pressure receiving area, and a free fall side port 5b2 having a small pressure receiving area. Pilot pipes 10a, 10b derived from both the ports 5b1, 5b2 are connected to a winding-down side pilot line 10 through a mode-switching valve 22 of a hydraulic pilot type.

[0054] A pilot port 22a of the mode-switching valve 22 is connected to an output port of the free fall valve 15. As shown in FIG. 1, when the free fall valve 15 is at a non-operation position (a), the mode-switching valve 22 is set to a normal winding-down position (a).

[0055] When in this state, the winding-down side remote control valve 8 is operated, pilot pressure is supplied to the normal winding-down side port 5b1 in the winding-down side pilot port 5b of the control valve 5. At this time, the free fall side port 5b2 is communicated with a tank T.

[0056] Accordingly, in this state, the control valve 5 operates without receiving any restriction at the stroke according to the operating amount (pilot pressure) of the winding-down side remote control valve 8. Thereby, an opening degree of the valve 5 is changed.

[0057] Next, when the free fall valve 15 is switched to the operation position (b), the mode-switching valve 22 is switched to the free fall position (b). Thereby, pilot pressure from the remote control valve 8 is supplied to the free fall side port 5b2 in the winding-down side pilot port 5b of the control valve 5. On the other hand, the normal winding-down side port 5b is communicated with the tank T.

[0058] In this state, a pressure receiving area of the

free fall side port 5b2 is smaller than that of the normal winding-down side port 5b1. Thereby, since the stroke operating force to the winding-down side of the control valve 5 is small, the valve stroke (opening degree) with respect to the operating amount of the winding-down side remote control valve 8 is smaller than that at the time of normal winding-down operation.

[0059] Because of this, as shown in FIG. 2, a stroke (maximum stroke = maximum opening degree) S_s of the control valve 5 at the time of free fall operation with respect to the maximum pilot pressure P_f is smaller than a pulse stroke S_f at the time of normal winding-down operation. Thereby, as shown in FIG. 3, the passage flow rate (maximum passage flow rate = allowable flow rate) Q_s of the control valve 5 at the maximum valve stroke S_s is smaller than the maximum passage flow rate Q_{max} at the time of normal winding-down operation.

[0060] Further, as shown in FIG. 4, it is set so that the allowable flow rate Q_s is obtained at fixed low speed N_s which is slightly higher than the minimum engine speed N_{min} in a relationship between engine speed (minimum valve N_{min} , maximum value N_{max}) and pump flow rate (minimum valve Q_{min} , maximum value Q_{max}).

[0061] Accordingly, as shown in FIG. 5, even if the engine speed exceeds the low speed N_s , the motor flow rate will not increase in excess of the allowable flow rate Q_s .

[0062] If setting is made as described above, at the time of free fall operation, all the pump flow rate is fed to the hydraulic motor 2 at the low engine speed (less than N_s). On the other hand, in the high engine speed region exceeding N_s , only the allowable flow rate Q_s which is a part of the pump flow rate is fed to the hydraulic motor 2.

[0063] At this time, a flow rate control valve 23 is provided on the pump line as shown in FIG. 1 in order to return surplus flow rate to the tank T.

[0064] According to this constitution, the motor flow rate is suppressed within the allowable flow rate Q_s irrespective of variation of engine speed. Therefore, there is no possible occurrence that the hydraulic motor 2 exceeds the allowable speed resulting in excessive speed state or random winding occurs due to the increase in engine speed.

[0065] Moreover, the free fall operation can be carried out by the operating means (remote control valve 8) common to normal operation. Because of this, there is no possible occurrence that the operation where the free fall operation from the winding-up operation is continuously carried out becomes complicated or an erroneous operation is brought forth, as in the case where both the operations are carried out by separate operating means.

EXAMPLE 2 (See FIG. 6)

[0066] In examples 2 to 8 described hereinafter, the same constituent elements as those of example 1 are

indicated by the same reference numerals, description of which are omitted.

[0067] In example 2, the winding-up side pilot port 5a is formed with an auxiliary port 5a1. Within the auxiliary port 5a1, a stopper 24 is provided movably forward and backward opposing to a spool 5c. At the time of free fall operation (when switched to an operating position (b) of the free fall valve 15), oil pressure of the pilot hydraulic source P_p is supplied to the auxiliary port 5a1 in the winding-up side pilot port 5a through a stopper hydraulic line 25. Thereby, the stopper 24 is moved forward toward the spool 5c (in a right direction in the figure) to limit the stroke.

[0068] Also in this constitution, the operation and effect similar to that of example 1 can be obtained.

EXAMPLE 3 (See FIGS. 7 to 9)

[0069] In the present example, there is employed the constitution that at the time of free fall operation, pilot pressure supplied to the winding-down side pilot port 5b of the control valve 5 is suppressed.

[0070] That is, the winding-down pilot line 10 is divided into a non-reduction pipeline 26 and a reduction pipeline 28. The non-reduction pipeline 26 causes pilot pressure from the winding-down side remote control valve 8 to pass to the pilot port 5b without modification. On the other hand, the reduction pipeline 28 reduces pilot pressure by a reducing valve 27.

[0071] A hydraulic pilot type mode-switching valve 29 is provided between both the pipelines 26, 28 and the pilot port 5b. Thereby, in the state that the switching valve 29 is set to the normal winding-down position (a), the non-reduction pipeline 26 is communicated with the pilot port 5b. As shown by the solid line in FIG. 8, normal pilot pressure (in the figure, P_f denotes the maximum pilot pressure) corresponding to the operating amount of the remote control valve 8.

[0072] On the other hand, when the free fall valve 15 is switched to the operating position (b), the mode-switching valve 29 is switched to the free fall position (b). Thereby, as shown by the phantom line in FIG. 8, pilot pressure which is lower than that of the normal winding-down operation (in the figure P_s denotes the maximum pilot pressure at that time) is supplied to the winding-down side port 5b of the control valve 5.

[0073] FIG. 9 shows a relationship between the pilot pressure set in this embodiment and the control valve stroke. The allowable flow rate (allowable speed) of the motor 2 is obtained by the maximum stroke S_s obtained by the maximum pilot pressure P_s at the time of free fall operation.

[0074] Thereby, the motor speed at the time of free fall operation is suppressed to a level not more than the allowable speed, similar to the above examples 1 and 2. Thereby, the excessive speed of the hydraulic motor 2 is prevented.

[0075] The specific operation for preventing the ex-

cessive speed of the motor according to the present embodiment will be now described. The pilot pressure is introduced into the free fall side port having a small pressure receiving area in the winding-down side pilot port of the control valve, whereby the stroke of the control valve is suppressed to throttle its opening degree. Further, the pilot pressure is introduced into the auxiliary port of the winding-down side pilot port and the stopper is actuated, whereby the stroke of the control valve is suppressed to throttle its opening degree. Further, the pilot pressure from the winding-down operating means (remote control valve) is reduced and is introduced into the pilot port of the control valve, whereby the stroke of the control valve is suppressed to throttle its opening degree.

[0076] Furthermore, according to example 3, adjustment and change of the motor allowable flow rate can be done easily by setting the reduction valve 27.

EXAMPLE 4 (See FIG. 10)

[0077] An electromagnetic proportional type-reducing valve 31 controlled by a controller is provided in the winding-down side pilot line 10.

[0078] The control valve 30 will not output a signal when the free fall switch 16 is turned off (at the time of normal winding-down operation). In this state, the reducing valve 31 is set to high pressure.

[0079] On the other hand, when the free fall switch 16 is turned on (at the time of free fall operation) the reducing valve 31 is set to low pressure by a signal from the controller 30.

[0080] Thereby, the maximum stroke of the control valve 5 is controlled to S_s in FIG. 9 to prevent the excessive rotation of the motor 2.

EXAMPLE 5 (See FIGS. 11 to 14)

[0081] In examples 1 to 4, there is employed the constitution that at the time of free fall operation, the stroke toward the winding-down side of the control valve is controlled to thereby control the motor flow rate. On the other hand, the present embodiment employs the constitution that when the engine speed rises during the free fall operation, the motor capacity is increased to limit the motor rotation.

[0082] That is, an electromagnetic proportional type-reducing valve 32 is provided in a motor capacity switching line 14 for switching the motor capacity. Thereby, the reducing valve 32 is controlled by the controller 33.

[0083] The controller 33 changes an output current according to the engine speed detected by a speed sensor 34. As shown in FIG. 12, at not more than the engine speed (hereinafter referred to as the allowable engine speed) at which flow rate Q_s corresponding to the motor allowable speed at the time of small capacity of the motor is discharged, full current I_{max} is output. At the engine speed region in excess of the former, it is set so

that an output current is reduced in inverse proportion to the engine speed.

[0084] Accordingly, at the time of free fall operation, when the engine speed is not more than the allowable speed N_s , oil pressure of the pilot hydraulic source P_p is output by the cylinder control valve 13 from the reducing valve 32 without modification, and the control valve 13 is set to the small capacity position (b). Therefore, the capacity regulating cylinder 12 is extended. Thereby, the hydraulic motor 2 is set to the small capacity q_{min} .

[0085] On the other hand, when the engine speed exceeds the allowable speed N_s , an input current of the reducing valve 32 is reduced in accordance with the setting of FIG. 12. Thereby, the secondary pressure (input pressure of the cylinder control valve 13) lowers. Accordingly, the cylinder control valve 13 is operated toward the large capacity position (a) so that the motor capacity increases as shown in FIG. 13.

[0086] Thereby, as shown in FIG. 14, even if the engine speed increases to the allowable speed N_s or more to increase the motor inflow flow rate, the motor speed does not exceed the allowable speed M_s .

(B) Next, a second form of embodiment of this invention will be described hereinafter on the basis of examples 6 to 8.

EXAMPLE 6 (See FIGS. 15 to 17)

[0087] In the FIG. 15 constitution, the winding-down initial speed is reduced at the start time of free fall operation, and the winding-down speed can be accelerated according to the operating amount.

[0088] In the figure, remote control pressure P_i of the winding-down side remote control valve (operating means) 8 is detected by a pressure sensor 40. A signal output from the pressure sensor 40 is given to a controller 41. A selecting switch (free fall instruction means) 42 is connected to the controller 41. The selecting switch 42 is provided with a normal operating button 42a for carrying out normal winding-up and winding-down, and a free fall operating button 42b. When the free fall operating button 42b is depressed, a free fall instruction is given to the controller 41. Thereby, the controller 41 sets capacity of the hydraulic motor 2 by preset motor capacity characteristics.

[0089] FIG. 16 shows the motor capacity characteristics (a relationship between remote control pressure P_i and a motor capacity M_q) set when the free fall instructions are output. As shown in the figure, The motor capacity characteristics M is large when the remote control pressure P_i is small. On the other hand, it is small as the remote control pressure P_i increases.

[0090] More specifically, when at the start time of free fall operation, the remote control pressure P_i is small, the controller 41 causes the secondary pressure of a reducing valve 43 (input pressure of the cylinder control

valve 13) to lower. Thereby, the cylinder control valve 13 is operated toward the large capacity position (a). Thereby, the motor capacity is set to a large level.

[0091] Further, when the free fall instructions is output, the controller 41 causes the free fall valve 15a from position (a) to position (b). Thereby, variable remote control pressure P_i in place of fixed pressure P_c is supplied to the pilot oil passage 44.

[0092] The remote control pressure P_i is introducing into a set pressure control valve 45 and a holding pressure control valve 46 separately.

[0093] The set pressure control valve 45 has a switching position switched from communication to cutoff (in the figure, shown by switching positions a to c conveniently). In the state that the winding-down side remote control valve 8 is not operated when the free fall valve 15 is switched to the position (b), the set pressure control valve 45 is at the position (a). When the winding-down lever 8a is operated, the position is switched from the position (b) to position (c).

[0094] As the set pressure control valve 45 is switched from the position (b) to position (c), the pressure control valve 18 is changed in set pressure from minimum to maximum. Accordingly, the winding-down pressure (pressure of the winding-down side pipeline 4) changed from minimum to maximum.

[0095] On the other hand, the holding pressure control valve 46 is switched to the communication position by the remote control pressure P_i when the free fall operation is selected.

[0096] As described above, where the remote control pressure P_i is small, that is, when the operating lever 8a starts to be operated in the free fall operation, the motor capacity M_q is made large and the winding-down pressure is made low. In this case, since immediately after the start of free fall operation, the motor capacity M_q is large, much oil is required for the drive of the hydraulic motor 2 whereby the initial speed is slow. As a result, even at the heavy load, the shock generated immediately after the start of free fall winding-down is extremely small. Moreover, it is designed so that the winding-down speed at the time of free fall becomes quick in proportion to the operating amount of the operating lever 8a. Therefore, the state can be shifted to the stationary operating state in a stable manner. Accordingly, operation in conformity with an operator's can be carried out.

[0097] The controller 41, the free fall valve 15, the set pressure control valve 45 and the pressure control valve 18 function as free fall operation control means.

[0098] FIG. 17A shows the change of the lever-operating amount. FIG. 17B shows the state when the winch drum 1 starts to move.

[0099] Pressure of the winding-down side oil path 4 is risen by operation of the lever, and the rotations of the winch drum 1 starts. Where the motor capacity I set to be small when the winding-down starts, the speed of the winch drum 1 rapidly increases (See N1 in FIG. 17). Thereby, the shock possibly occurs depending on the

state of a hanging load. However, in the present example, an increase in speed of the winch drum 1 is gentle. Therefore, the state can be shifted to the stationary operating state without being attended by the shock (See N2 in FIG. 17B).

EXAMPLE 7 (See FIG. 18)

[0100] In the present example, the control valve 5 is switched by either remote control pressure P_i from the winding-down side remote control valve 8 or pilot pressure P_j from a pilot pressure supply valve (control valve switching means) provided separately from the winding-down side remote control valve 8.

[0101] Here, $P_j > P_i$. Reference numeral 51 denotes a shuttle valve for selecting a high level of the remote control pressure P_i and the pilot pressure P_j .

[0102] When a free fall operating button 42b of the mode switch 42 is depressed, the controller 41 switches the pilot pressure supply valve 50 from a position (a) to a position (b). Then, when the pilot pressure P_j is derived from the pilot pressure supply valve 50, the shuttle valve 51 selects a high level of the pilot pressure P_j and the remote control pressure P_i . Next, the pilot pressure P_j is given to the pilot port 5b of the control valve 5 due to $P_j > P_i$. Thereby, the control valve 5 is switched to the winding-down position (c) in preference to the operation of the winding-down side remote control valve 8.

[0103] In this case, the control valve 5 can be quickly switched to the winding-down position without waiting the remote control pressure P_i from the winding-down side remote control valve 8 at the time of the free fall operation. Accordingly, the time from the start of winding-down to the maximum speed. Thereby, acceleration can be promoted.

[0104] It will be appreciated that where the free fall mode is not selected, the pilot pressure P_j is not derived. Thereby, the remote control pressure P_i derived from the winding-down side remote control valve 8 is introduced into the pilot port 5b of the control valve 5. Thereby, the winding-up and winding-down operation can be done at normal speeds.

EXAMPLE 8 (See FIGS. 19 and 20)

[0105] In the present example, a relief valve 55 provided on the bypass oil passage 4a is directly controlled by the controller 41.

[0106] The relief pressure characteristics for changing the relief pressure of the electromagnetic relief valve 55 from low pressure to high pressure in a predetermined pattern according to the lever stroke (remote control pressure P_i) of the operating lever 8a is stored in advance in a memory. Thereby, a relief pressure is read out of the memory according to the remote control pressure P_i detected by the pressure sensor 40. Thereby, a relief pressure signal is given to the electromagnetic relief valve 55.

[0107] FIG. 20 shows the above-described relief pressure characteristics. A relief pressure P1 is constant when the remote control pressure Pi is from P0 to PA. As the remote control pressure increases from PA to PB, the relief pressure P1 increases from P1 to P2.

[0108] According to the above constitution, the relief pressure characteristics can be suitably set. Furthermore, there is an advantage that the speed responsiveness is high, and the operation feeling is excellent.

[0109] As described above, in the first embodiment, the stroke of the control valve can be suppressed to contract an opening degree thereof by the following means:

(1) In the free fall operation, the pilot pressure is introduced into the free fall side port having a small pressure receiving area in the winding-down side pilot port of the control valve.

(2) In the free fall operation, the pilot pressure is introduced into an auxiliary port of the winding-down side pilot port to actuate a stopper.

(3) In the free fall operation, the pilot pressure from the winding-down operating means (remote control valve) is reduced and introduced into the pilot port of the control valve.

[0110] Since the motor capacity is increased according to the rise of the engine, the excessive speed of the motor in the free fall operation can be prevented. Thereby, the random winding can be prevented from occurrence.

[0111] Moreover, the free fall operation can be carried out by the same operating means (remote control valve) common to the normal operation. Therefore, the continuous operation particularly where the free fall operation is continuously carried out from the winding-up operation as in the case where both the operations are carried out by separate operating means is not complicated or erroneous operation is possibly brought forth.

[0112] The second embodiment has the following effects. That is, when the free fall operation is selected by the free fall instruction means, the tilting angle of the variable capacity type hydraulic motor is controlled. Thereby, the capacity of the hydraulic motor is set to a small capacity from a large capacity in proportional to the winding-down operating amount. Thus, the winding-down operation is carried out using the operating means common in operation to the free fall operation. Since the capacity of the hydraulic motor is large at the time of starting the free fall operation, the initial speed of the free fall is slow. Thereby, the free fall operation can be carried out safely.

[0113] At the time of starting the winding-down operation, the pressure of the winding-down side oil passage is set to be low. Therefore, even if the hanging load is large, no shock occurs when the winding-down starts.

[0114] The winding-down side oil passage is risen in pressure in proportional to the operating amount of the operating means. Therefore, increasing and decreasing

of the hook falling speed can be done according to the operating amount. For example, if the winding-down operating amount is increased in the state that the capacity of the variable capacity type hydraulic motor is set to be small, the free falling can be done at high speeds.

[0115] Further, when the free fall operation is started, the control valve switching means independently switches the control valve to the winding-down side. Thereby, the time required from the start of free falling to the maximum winding-down speed in the state that the hanging load is applied is shortened. Accordingly, the responsiveness can be enhanced.

(C) In the following, a third form of embodiment of the invention will be described hereinafter on the basis of the following Examples 9 to 12. This example relates to a control device for a hydraulic winch to enable the free fall operation in a closed circuit.

EXAMPLE 9 (See FIGS. 21 to 23)

[0116] In FIG. 21, reference numeral 101 denotes a hydraulic motor of a variable capacity type for driving a winch drum not shown. Both pipelines 102, 103 on the winding-up side and winding-down side, respectively, of the motor 101 are directly connected to both discharge ports of a hydraulic pump 104 of a variable capacity type and a 2-directional discharge type. Thereby, a motor closed circuit A is constituted. The discharge direction and the discharge flow rate of the hydraulic pump 104 are controlled to control the rotational directions (winding-up and winding-down) and the rotational speed of the hydraulic motor 101.

[0117] The constitution of a pump control means for controlling the pump 104 will be described below.

[0118] A tilting cylinder 105 for operating the tilting of the pump 104 on either the winding-up side or the winding-down side is connected to a hydraulic source 106 for the cylinder 105 and a tank T through a cylinder control valve 107 which is a hydraulic pilot type servo valve. The control valve 107 and the tilting cylinder 105 are controlled by pressure (remote control pressure) from both remote control valves 109, 110 on the winding-up side and winding-down side operated by a lever 108.

[0119] That is, when the lever 108 is operated on the winding-up side on the right-hand in the figure or on the winding-down side on the left-hand in the figure, the remote control pressure corresponding to the lever operating amount from the remote control valve 109 on the winding-up side or the remote control valve 110 on the winding-down side is output. The cylinder control valve 107 is switched from a neutral position x to a winding-up position y on the right-hand in the figure or a winding-down position z on the left-hand in the figure.

[0120] Oil pressure corresponding to the remote control valve operating amount are fed to either an oil chamber 105a on the winding-up side of the tilting cylinder 105 at the winding-up position y or an oil chamber 105b

on the winding-down side thereof at the winding-down position z, respectively. Thereby, the cylinder 105 is driven on the winding-up side or the winding-down side to change the tilting. Oil corresponding to the tilting is fed to the pipeline 102 on the winding-up side or the pipeline 103 on the winding-down side to rotate the motor 101.

[0121] Out of both tilting control circuits 111, 112 on the winding-up side and the winding-down side for connecting the tilting cylinder 105 and the cylinder control valve 107, tilting control circuit 112 on the winding-down side is provided with a hydraulic pilot-type switching valve 113.

[0122] The switching valve 113 has a winding-down stop position a for communicating the oil chamber 105b on the winding-down side of the tilting cylinder 105 with the tank T, and a winding-down position b for feeding oil from the hydraulic source 106 to the oil chamber 105. At the same time, the switching valve 113 has, as a pilot port for receiving pilot pressure, a first pilot port 114 for introducing pressure (holding pressure on the winding-down side) P1 of the pipe line 103 on the winding-down side, and a second pilot port 115 for introducing remote control pressure (winding-down instruction pressure) P2 by operation the remote control valve 110 on the winding-down side.

[0123] On both the pilot ports 114, 115 are provided pistons 116, 117 as a pressure receiving part operated by receiving the pilot pressure so that the pistons move together. The total pressure of a winding-down side holding pressure P1 and a winding-down instruction pressure P2 exerting on both the pistons 116, 117 can switch the switching-valve 113.

[0124] With respect to pressure receiving areas of both the pistons 116, 117, the pressure receiving area for the first piston 16, which receives relatively high pressure (the winding-down side holding pressure P1) is set to be small, and that for the second piston 17, which receives relatively low pressure (the winding-down instruction pressure P2) is set to be large.

[0125] Reference numeral 118 denotes a spring resisting to the pilot pressure.

[0126] The constitution of a motor speed switching means for setting the capacity of the motor 101 to a small value at the time of the free fall operation to rise the motor speed will be described below.

[0127] Reference numeral 119 denotes a capacity-regulating cylinder for changing the motor capacity by changing the tilting of the motor 101. The motor 101 is set to a large capacity in the state that the cylinder 119 is contracted, while being set to a small capacity in the state that the cylinder is expanded.

[0128] An expanded side oil chamber 119a of the capacity-regulating cylinder 119 is connected to the winding-up side pipeline 102 and the tank T through a hydraulic pilot switching type capacity control valve 120.

[0129] The capacity control valve 120 has a large capacity position x and a small capacity position y. At the large capacity position x, the expanded side oil chamber

119a is communicated with the tank T so that the capacity regulating cylinder 119 contracts (the motor 101 is set to a large capacity).

[0130] On the other hand, when the control valve 120 is switched to the small capacity position y, oil of the winding-up side pipeline 102 is introduced into the expanded side oil chamber 119a. Thereby, the cylinder 119 expands (the motor 101 is set to a small capacity area).

[0131] A small capacity pilot port 120a of the capacity control valve 120 is connected to an output port of a free fall valve (an electromagnetic switching valve) 122 constituting a mode switching means through a motor capacity switching line 121.

[0132] The free fall valve 122 is set to a non-operating position x in the figure at the time of normal operation (at the time of winding-up and normal winding-down). In this state, the capacity control valve 120 is held at a large capacity position x shown.

[0133] When, from this state, a free fall switch 123 constituting the mode switching means is turned on, the free fall valve 122 is switched to an operating position y. Oil pressure of a pilot hydraulic source 124 is supplied to the small capacity pilot port 120a of the capacity control valve 120 so that the control valve 120 is switched to a small capacity position y.

[0134] Thereby, the capacity-regulating cylinder 119 is operated to be expanded, and the motor 101 is set to a small capacity.

[0135] Next, the operation of this device will be described.

[0136] At the time of winding-up operation and at the time of normal winding-down operation, the free fall valve 122 is set to the non-operating position x, and the motor capacity is set to a large capacity.

[0137] In this condition, the motor 101 is rotated at the speed (lower than that at the time of free fall operation) corresponding to the operating amount, by the action of the cylinder control valve 107 and the tilting cylinder 105 on the basis of the operation of both the remote control valves 109, 110 on the winding-up side or winding-down side, and the winding-up operation or the normal winding-down operation is carried out.

[0138] On the other hand, at the time of free fall operation, the free fall valve 122 is set to the operating position y, and the motor capacity is set to a small capacity. Because of this, the winding-down operation at the high speed is enabled.

[0139] At the time of free fall operation, the total pressure of the winding-down side holding pressure P1 and the winding-down instruction pressure P2 is applied as a pilot pressure to the switching valve 113, as described above. When the total pressure reaches a set valve at which winding-down starts, the position is switched to the winding-down position b.

[0140] This point will be described in detail.

Fk: Return spring force of a the spring 118 at the time of cracking at which the switching valve 113 is

switched to the winding-down position b
 A1: Pressure receiving area of the first piston 116
 P1: Winding-down side holding pressure
 A2: Pressure receiving area of the second piston 117
 P2: Winding-down instruction pressure

When the switching valve 113 is switched to the winding-down position b, this state is expressed by the relationship of the following equation (1):

$$F_k = A1 \cdot P1 + A2 \cdot P2 \quad (1)$$

Whereby, in order that the switching valve 113 be stayed at the winding-down stop position a, the following equation (2) need be fulfilled:

$$F_k > A1 \cdot P1 + A2 \cdot P2 \quad (2)$$

When the equation (2) is modified, the following equation (3) is obtained:

$$F_k < (-A2 \cdot P2 + F_k) / A1 \quad (3)$$

This equation (3) represents the diagonal area of FIG. 22.

[0141] That is, when the coordinate represented by the winding-down side holding pressure P1 and the winding-down instruction pressure P2 is within the diagonal area of the graph of FIG. 22, the switching valve 113 is at the winding-down stop position a. Even if the cylinder side control valve 107 should be switched to the winding-down position z by the operation of the winding-down side remote control valve 110, the pump 104 assumes a neutral (tilting 0) state. Accordingly, the discharge flow amount of oil from the pump 104 is 0, and the motor 101 is not rotated.

[0142] When the operating amount of the winding-down side remote control valve 110 increases so that the coordinate represented by the winding-down side holding pressure P1 and the winding-down instruction pressure P2 is outside of the diagonal area of the graph as in point X in FIG. 22, the switching valve 113 is switched to the winding-down position b. Thereby, the winding-down side tilting of the pump 104 is set to the value corresponding to the operating amount of the remote control valve so that the motor 101 takes winding-down rotation at the high speed, and the free fall operation is carried out.

[0143] In order to stop the rotation of the motor 101 when the coordinate of pressure is at point X of FIG. 22 during the free fall operation, it is necessary to move the pressure coordinate from the point X into the diagonal area. This movement of the coordinate is carried out when at least one of the winding-down side holding

pressure P1 and the winding-down instruction pressure P2 reduces.

[0144] In the present device, when the load is landed, the winding-down side holding pressure P1 lowers to a value 0 or a value near 0. Paying attention thereto, the switching characteristic of the switching valve 113 is set so that when the winding-down side holding pressure P1 lowers to a value less than a certain value (pressure at the time of landing), the switching valve 113 is switched to the winding-down stop position a.

[0145] Thereby, even if the remote control valve 110 should be subjected to the winding-down operation at the time of landing, the free fall operation is automatically stopped.

[0146] In the closed circuit constitution, the free fall operation provided with two functions, that is, the high-speed winding-down rotation and the winding-down stop at the time of landing becoming enabled.

[0147] Further, as shown in FIG. 23, the pump tilting (pump discharge flow rate) changes corresponding to the operating amount (the winding-down instruction pressure P2) of the remote control valve 110. Therefore, the free fall speed can be suitably controlled outside the diagonal area of FIG. 22 by operation of the lever.

[0148] In this case, the pressure receiving areas of both the pistons 116, 117 of the switching valves 113 are set to be small on the first piston 116 side and to be large on the second piston 117 side. Therefore, the change in speed with respect to the change of the winding-down instruction pressure P2 becomes large, and the speed controllability caused by the lever operation is improved.

[0149] Since, when the total value of the winding-down holding pressure and the winding-down instruction pressure caused by the winding-down operation reaches the set value for the winding-down start, the free fall operation is started and the winding-down speed changes corresponding to the winding-down instruction pressure, the free fall speed can be freely controlled by an operator. Therefore, the operability at the time of free fall operation is improved.

[0150] In the present embodiment, a hydraulic pilot type-switching valve is used as a switching valve. Since the whole hydraulic control becomes enabled, equipment for electric control (a controller or a pressure detection means) is unnecessary as compared with a case using an electro-magnetic switching valve. Accordingly, the circuit can be constituted merely by hydraulic equipment.

[0151] In this case, in the switching valve, it is set so that the pressure receiving area of the first port into which is introduced high winding-down side holding pressure is small, and the pressure receiving area of the second port into which is introduced low winding-down instruction pressure is large, and therefore, the winding-down speed control corresponding to the winding-down operating amount can be easily carried out. Further, since the spring force resisting to the winding-down side holding pressure can be weakened, the switching valve

can be constituted compact.

EXAMPLE 10 (See FIG. 24)

[0152] With respect to EXAMPLE 10, those different from EXAMPLE 9 will be mainly explained.

[0153] EXAMPLE 9 employs the constitution in which when the winding-down side holding pressure P1 assumes a value less than a set value at the time of winding-down, the switching valve 113 is always switched to the winding-down stop position a and the winding-down operation automatically stops. On the other hand, the present example employs the constitution in which by switching the mode, even if the winding-down side holding pressure P1 lowers to a value less than a set value, the winding-down operation can be continued.

[0154] That is, there is provided an electro-magnetic switching control valve 126 between a second pilot port 115 of a switching valve 113, a winding-down side remote control valve 110 and a pilot hydraulic source 124. Further, there are provided a controller 127 for controlling the control valve 126, a pressure gage 128 for detecting a winding-down instruction pressure P2 to input it into the controller 127, and a mode switching switch 129 as a mode switching means for switching a winding-down mode between an automatic stop mode for automatically stopping the winding-down operation and a normal mode not to effect automatic stop.

[0155] The switching control valve 126 has a first position x for feeding the winding-down instruction pressure P2 to the second pilot port 115 by the operation of the winding-down side remote control valve 110, and a second position y for feeding pressure of the pilot hydraulic source 124 directly to the port 115 without decreasing the pressure.

[0156] The switching control valve 126 is set to the first position x shown when the mode switching switch 129 is turned off. In this state, when the winding-down side holding pressure P1 lowers to a value less than a set value as described in EXAMPLE 9, the winding-down operation automatically stops.

[0157] On the other hand, when the mode-switching switch 129 is turned on, the switching control valve 126 is switched to the second position y by a signal from the controller 127. In this state, pressure from the hydraulic source 124 is supplied to the second pilot port 115 of the switching valve 113. Therefore, the switching valve 113 is held at the winding-down position b irrespective of the change in magnitude of the winding-down side holding pressure P1.

[0158] Accordingly, even if the load is landed, the winding-down operation can be continued corresponding to the winding-down operating amount as long as the winding-down operation is carried out.

[0159] Such an operating mode as described can be used where for example, in the work in which a crushing rod is free fallen to crush rocks in water, winding-down operation is continued to crush them positively for a

fixed time even after the crushing rod arrives at the rocks.

[0160] The winding-down operation can be continued irrespective of the change in magnitude of the winding-down side holding pressure, as necessary.

EXAMPLE 11 (See FIG. 25)

[0161] In the present example, an electromagnetic switching type switching valve 130 is used in place of the hydraulic pilot-type switching valve 113 in EXAMPLES 9 and 10. The switching valve 130 is controlled by a signal from a controller 131.

[0162] Into the controller 131 is input the winding-down side holding pressure P1 by a pressure gage 132, and the winding-down instruction pressure P2 by a pressure gage 133. When the total pressure of both the pressures P1, P2 reaches a value above a set value, a switching signal is output from the controller 131 to the switching valve 130 so that the switching valve 130 is switched to the winding-down position b. When the winding-down side holding pressure P1 lowers to a value less than a set value, a switching signal from the controller 131 stops so that the switching valve 130 returns to the winding-down stop position a.

[0163] According to this constitution, a general electromagnetic valve can be used as compared with a case using the special switching valve 113 provided with both the first and second pilot ports 114, 115 as in EXAMPLES 9, 10. Therefore, the cost of parts is low, and the constitution of a device can be simplified.

[0164] Further, since the switching instruction of the switching valve 130 is carried out by the controller 131, the switching characteristic of the switching valve 130 can be freely selected in a wide range.

[0165] Since the electromagnetic switching valve is used as a switching valve, the switching valve can be controlled directly by an electric signal. Since the general valve can be used as compared with a case using a hydraulic switching valve provided with a special pilot port, the cost of parts is low, and the constitution of a device can be simplified.

[0166] Further, since the switching instruction of the switching valve is carried out by a controller, the switching characteristic of the switching valve 130 can be freely selected in a wide range.

EXAMPLE 12 (See FIG. 26)

[0167] In the above-described examples, there employs the constitution in which the tilting cylinder 105 is controlled indirectly through the cylinder control valve 107 by the remote control valves 109, 110, whereas in the present example, the cylinder control valve 107 is omitted, and remote control pressure from the remote control valves 109, 110 is fed directly (via the switching valve 113 on the winding-down side) to the tilting cylinder 105. Thereby, the tilting cylinder 105 is controlled

directly by the operation of the remote control valves 109, 110.

[0168] Also in this case, basically the same operation and effect as the EXAMPLES 9 to 11 can be obtained.

[0169] Incidentally, while in the above-described examples, there employs the constitution in which the motor capacity is changed in magnitude to switch the motor speed to high or low speeds, it is noted that other motor speed changing means can be used. For example, a speed change mechanism is provided between the motor 101 and the winch drum, and a means for switching the mechanism to the high-speed side or the low speed side can be used.

FIG. 1

FIG. 2 CONTROL VALVE STROKE
NORMAL OPERATION (PILOT PORT 5b1)
FREE FALL OPERATION (PILOT PORT 5b2)
REMOTE CONTROL VALVE PILOT PRESSURE

FIG. 3 PASSAGE FLOW RATE

FIG. 4 CONTROL VALVE STROKE

FIG. 5 PUMP FLOW RATE

FIG. 6 ENGINE SPEED

FIG. 7 MOTOR FLOW RATE

FIG. 8 ENGINE SPEED

FIG. 6

FIG. 7

FIG. 8

PILOT PRESSURE
NORMAL WINDING DOWN OPERATION
FREE FALL OPERATION
REMOTE CONTROL VALVE-OPERATING AMOUNT
LEVER REMOTE CONTROL VALVE-OPERATING AMOUNT

FIG. 9 CONTROL VALVE STROKE
REMOTE CONTROL VALVE PILOT PRESSURE

FIG. 10 CONTROLLER

FIG. 11 CONTROLLER

FIG. 12 INPUT CURRENT

ENGINE SPEED
(PUMP FLOW RATE)

FIG. 13 MOTOR CAPACITY

ENGINE SPEED

FIG. 14 MOTOR SPEED

MOTOR ALLOWABLE SPEED

ENGINE SPEED

FIG. 15 WINDING UP

WINDING DOWN

CONTROLLER

FIG. 16 PRIOR ART

PRESENT INVENTION

MOTOR CAPACITY

PILOT PRESSURE

RELATION BETWEEN PILOT PRES-

FIG. 17A SURE AND MOTOR CAPACITY

PRIOR ART

PRESENT INVENTION

LEVER-OPERATING AMOUNT

5 FIG. 17B WINCH DRUM SPEED
TIME

FIG. 18 WINDING UP

WINDING DOWN

CONTROLLER

10 FIG. 19 WINDING UP

WINDING DOWN

CONTROLLER

FIG. 20 RELIEF PRESSURE

15 REMOTE CONTROL PRESSURE (LEVER STROKE)

Claims

20 1. A control device for a hydraulic drive winch, comprising:

a winch drum;

a variable capacity type hydraulic motor for driving said winch drum;

a hydraulic pump as a hydraulic source for said hydraulic motor;

a control valve for controlling a supply and a discharge of pressure oil to said hydraulic motor;

winding-up operating means for operating said control valve to a winding-up side;

winding-down operating means for operating said control valve to a winding-down side;

motor capacity control means for controlling a capacity of said hydraulic motor; and

free fall instruction means for outputting free fall instructions, wherein said motor capacity control means is actuated by free fall instructions from said free fall instruction means to set said hydraulic motor to a small capacity, in which state, said winding-down operating means is operated to thereby rotate said winch drum at high speeds to effect free fall operation.

2. A control device for a hydraulic drive winch, comprising:

a winch drum;

a variable capacity type hydraulic motor for driving said winch drum;

a hydraulic pump as a hydraulic source for said hydraulic motor;

a control valve for controlling a supply and a discharge of pressure oil to said hydraulic motor;

winding-up operating means for operating said control valve to a winding-up side;

winding-down operating means for operating said control valve to a winding-down side;
 motor capacity control means for controlling a capacity of said hydraulic motor;
 free fall instruction means for outputting free fall instructions, wherein said motor capacity control means is actuated by free fall instructions from said free fall instruction means to set said hydraulic motor to a small capacity, in which state, said winding-down operating means is operated to thereby rotate said winch drum at high speeds to effect free fall operation; and
 control valve control means, an opening degree of said control valve relative to an operating amount of said winding-down operating means being controlled to be smaller than that of normal winding-down operation where no free fall instructions is present, wherein in said free fall operation, a flow rate supplied to said hydraulic motor is not more than an allowable flow rate of said hydraulic motor.

3. The control device for a hydraulic drive winch according to claim 2, wherein said control valve is of a hydraulic pilot type provided with pilot ports for both the winding-up side and the winding-down side, respectively, and said winding-down operating means comprises a remote control valve.
4. The control device for a hydraulic drive winch according to claim 3, wherein said control valve control means comprising:
 - (i) a winding-down side pilot port of said control valve, said winding-down side pilot port having a normal winding-down side port with a relatively large pressure receiving area and a free fall side port with a relatively small pressure receiving area; and
 - (ii) a pilot pressure switching valve, said pilot pressure switching valve introducing a pilot pressure from said winding-down operating means into said normal winding-down side port in case of normal winding-down operation, and introducing it into said free fall side port in case of free fall operation.
5. The control device for a hydraulic drive winch according to claim 3, wherein said control valve control means comprises an auxiliary port provided in a winding-up side pilot port, a pilot pressure being supplied to said auxiliary port at the time of free fall operation; and
 said auxiliary port has a stopper for controlling a stroke to the winding-down side of said control valve when the pilot pressure is introduced.
6. The control device for a hydraulic drive winch ac-

ording to claim 3, wherein said control valve control means comprises pilot pressure switching means, said pilot pressure switching means reducing the pilot pressure from said winding-down operating means more than that of the normal winding-down operation at the time of free fall operation to introduce it into the pilot port of said control valve.

7. The control device for a hydraulic drive winch according to claim 3, further comprising:
 - a reducing valve provided in the winding-down side pilot port of said control valve, said reducing valve being set to a high pressure at the time of normal winding-down operation, and set to a low pressure at the time of free fall operation.
8. A control device for a hydraulic drive winch, comprising:
 - a winch drum;
 - a variable capacity type hydraulic motor for driving said winch drum;
 - a hydraulic pump as a hydraulic source for said hydraulic motor;
 - a control valve for controlling a supply and a discharge of pressure oil to said hydraulic motor;
 - winding-up operating means for operating said control valve to a winding-up side;
 - winding-down operating means for operating said control valve to a winding-down side;
 - motor capacity control means for controlling a capacity of said hydraulic motor, said motor capacity control means increasing a motor capacity according to an engine speed for driving said hydraulic pump on a high engine speed side to thereby control the speed of said hydraulic motor to not more than an allowable speed of said hydraulic motor at the time of free fall operation; and
 - free fall instruction means for outputting free fall instructions, wherein said motor capacity control means is actuated by free fall instructions from said free fall instruction means to set said hydraulic motor to a small capacity, in which state, said winding-down operating means is operated to thereby rotate said winch drum at high speeds to effect free fall operation.
9. The control device for a hydraulic drive winch according to claim 8, wherein said motor capacity control means comprises:
 - a motor capacity regulating actuator for changing a capacity of said hydraulic motor;
 - a hydraulic pilot type actuator control valve for operating said actuator;

a pilot pressure control valve for controlling a pilot pressure introduced into said actuator control valve; and
a controller for controlling said pilot pressure control valve according to the engine speed.

10. A control device for a hydraulic drive winch, comprising:

a winch drum;
a variable capacity type hydraulic motor for driving said winch drum;
a hydraulic pump as a hydraulic source for said hydraulic motor;
a control valve for controlling a supply and a discharge of pressure oil to said hydraulic motor;
winding-up operating means for operating said control valve to a winding-up side;
winding-down operating means for operating said control valve to a winding-down side;
motor capacity control means for controlling a capacity of said hydraulic motor;
free fall instruction means for outputting free fall instructions; and
free fall control means, said free fall control means changing the capacity of said hydraulic motor from a large capacity to a small capacity in proportional to an operating amount of said winding-down operating means.

11. The control device for a hydraulic drive winch according to claim 10, wherein said free fall control means is designed so that a pressure of winding-down side oil passage leading to said hydraulic motor from said control valve in proportional to the operating amount of said winding-down operating means.

12. The control device for a hydraulic drive winch according to claim 10, further comprising:

control valve switching means switching said control valve to the winding-down side in preference to a switching operation from said winding-down operating means when a free fall operation is selected.

13. The control device for a hydraulic drive winch according to claim 10, further comprising:

a relief valve provided on a bypass oil passage connecting a winding-up pipeline to a winding-down pipeline, a relief pressure of said relief valve being changed in proportional to a operating amount of said winding-down operating means.

14. A control device for a hydraulic drive winch, comprising:

a winch drum;
a hydraulic motor for driving said winch drum;
a hydraulic pump as a hydraulic source for said hydraulic motor, said hydraulic pump and said hydraulic motor being connected by a closed circuit;
motor speed switching means for switching said hydraulic motor to a high speed rotation mode for winding-down at a relatively high speed or a low speed rotation mode for winding-down at a relatively low speed;
winding-down operating means for outputting a winding-down instruction signal of a winding-down operation; and
pump control means for controlling a discharge direction and a discharge flow rate of said hydraulic pump, said pump control means being constituted so as to control said hydraulic pump in a direction in which the winding-down operation stops with the result that the rotating of said hydraulic motor stops when winding-down side holding pressure of said closed circuit lowers to a value less than a set value of the winding-down stop in a state that said motor speed switching means is set to a high speed rotation mode and said winding-down operating means is subjected to the winding-down operation.

15. The control device for a hydraulic drive winch according to claim 14, wherein

said hydraulic pump comprises a variable capacity type hydraulic pump; and
said pump control means has a winding-down side tilting control circuit for controlling the tilting on the winding-down side of said hydraulic pump.

16. The control device for a hydraulic drive winch according to claim 15, further comprising:

a switching valve provided in said winding-down side tilting control circuit, said switching valve having a winding-down position in which said hydraulic motor takes winding-down rotation and a winding-down stop position in which winding-down rotation of said hydraulic motor stops, and being switched from said winding-down position to said winding-down stop position when winding-down side holding pressure lowers to a value less than a set value.

17. The control device for a hydraulic drive winch according to claim 16, wherein

said switching valve is set to a winding-down position when a total value of the winding-down side holding pressure and the winding-down instruction pressure caused by winding-down operation of the winding-down operating means reaches a set value for start of winding-down, said switching valve controlling the winding-down rotational speed corresponding to said winding-down instruction pressure.

18. The control device for a hydraulic drive winch according to claim 16, wherein

said switching valve comprises a hydraulic pilot type switching valve.

19. The control device for a hydraulic drive winch according to claim 18, wherein

the winding-down side holding pressure and the winding-down instruction pressure caused by the winding-down operation of the winding-down operating means are introduced, as a pilot pressure in a direction of setting said switching valve to a winding-down position, into a hydraulic pilot port of said switching valve.

20. The control device for a hydraulic drive winch according to claim 19, wherein

the pilot port of said switching valve is divided into a first port into which the winding-down side holding pressure is introduced, and a second port into which the winding-down instruction pressure is introduced, and a pressure receiving area of said first port is set to be smaller than that of said second port.

21. The control device for a hydraulic drive winch according to claim 16, wherein

said switching valve comprises an electromagnetic switching valve.

22. The control device for a hydraulic drive winch according to claim 22, further comprising:

a controller for outputting a switching signal to a winding-down stop position to said switching valve when said winding-down side holding pressure lowers to a value less than a set value.

23. The control device for a hydraulic drive winch according to claim 22, wherein

said controller is constituted so that to said switching valve,

(a) is output a switching signal when the total

value of the winding-down side holding pressure and the winding-down instruction pressure reaches a set value for start of winding-down, and

(b) is output a signal in a direction that the winding-down rotational speed changes in response to the winding-down instruction pressure.

24. The control device for a hydraulic drive winch according to any one of claims 14 to 23, further comprising:

mode switching means for switching a winding-down mode between an automatic stop mode and a normal mode.

25. The control device for a hydraulic drive winch according to claim 24, wherein said pump control means

(a) stops the winding-down operation when the winding-down side holding pressure lowers to a value less than a set value of winding-down stop, in the state that said mode switching means is set to the automatic stop mode, and (b) controls the hydraulic pump in a direction that the winding-down operation is carried out irrespective of the value of the winding-down side holding pressure, in the state that said mode switching means is set to the normal mode.

FIG. 1

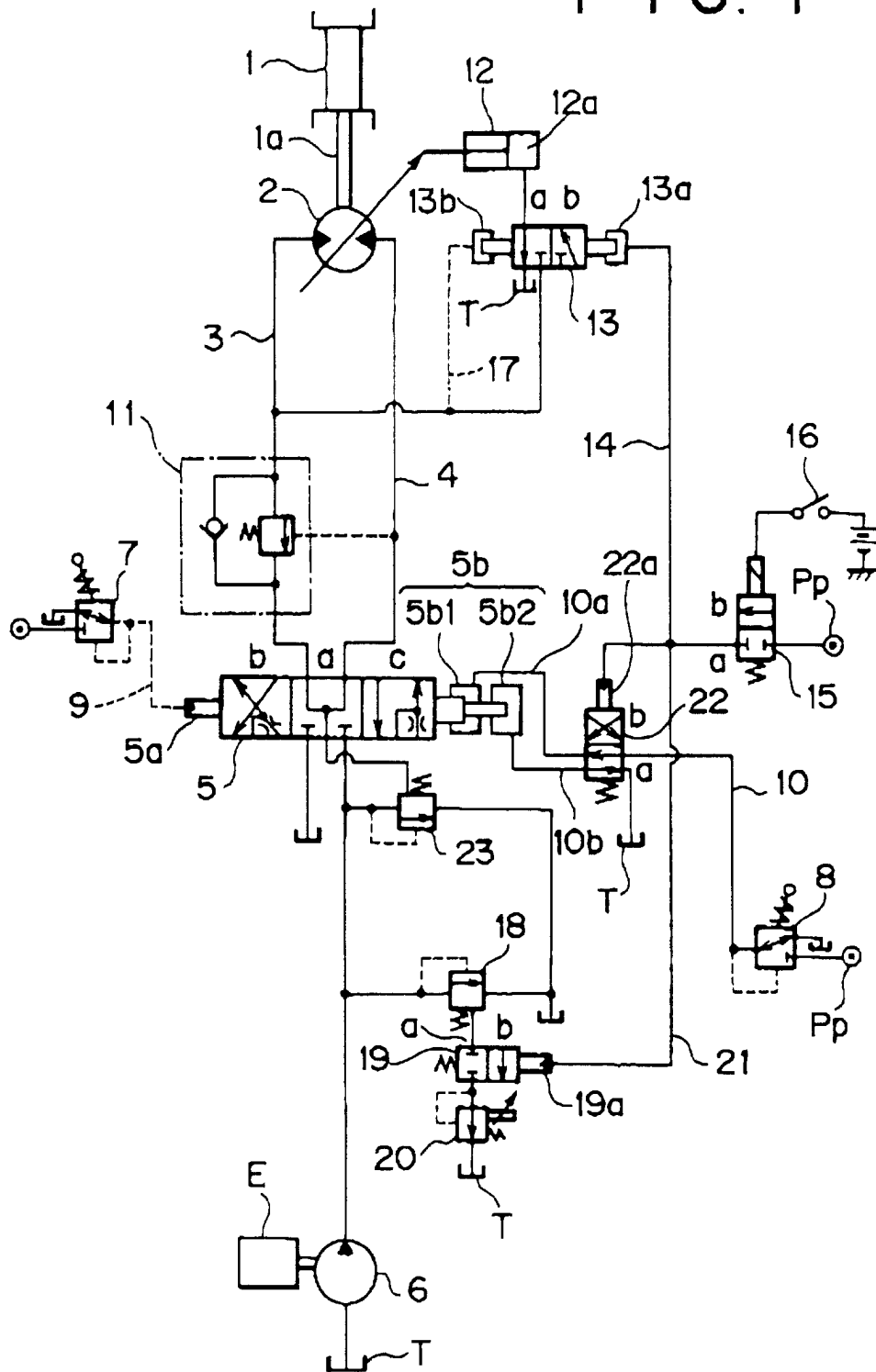


FIG. 2

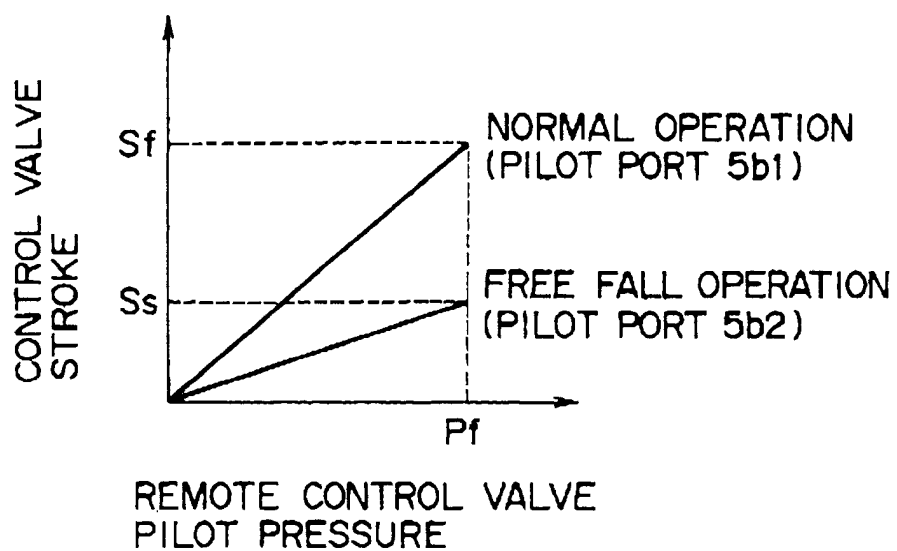


FIG. 3

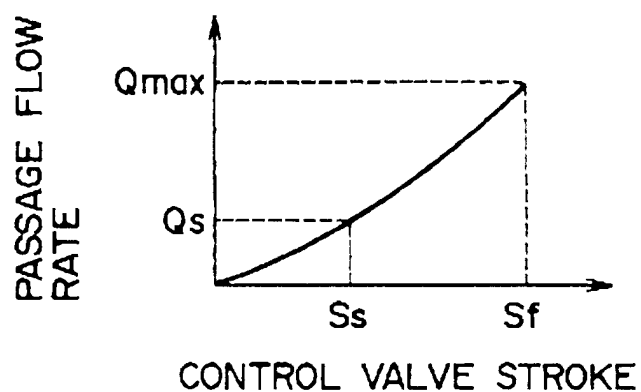


FIG. 4

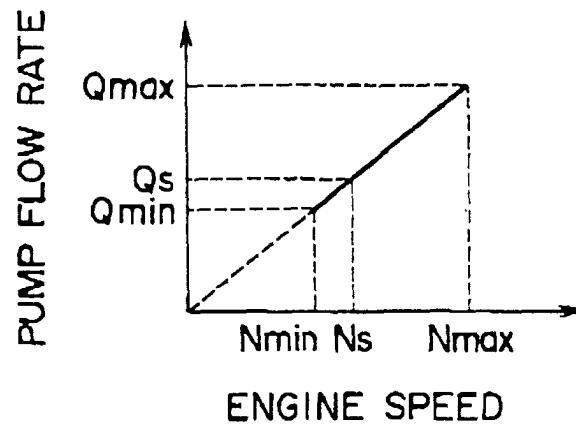


FIG. 5

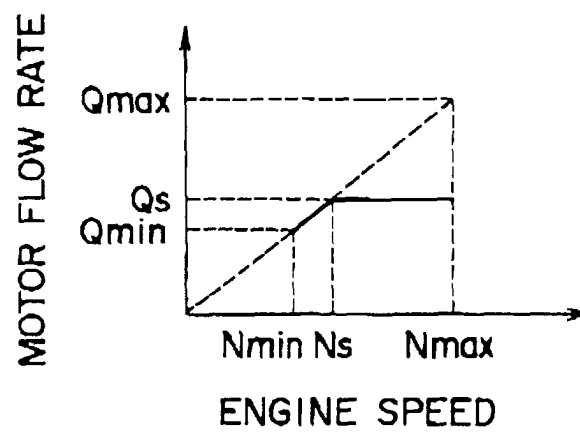


FIG. 6

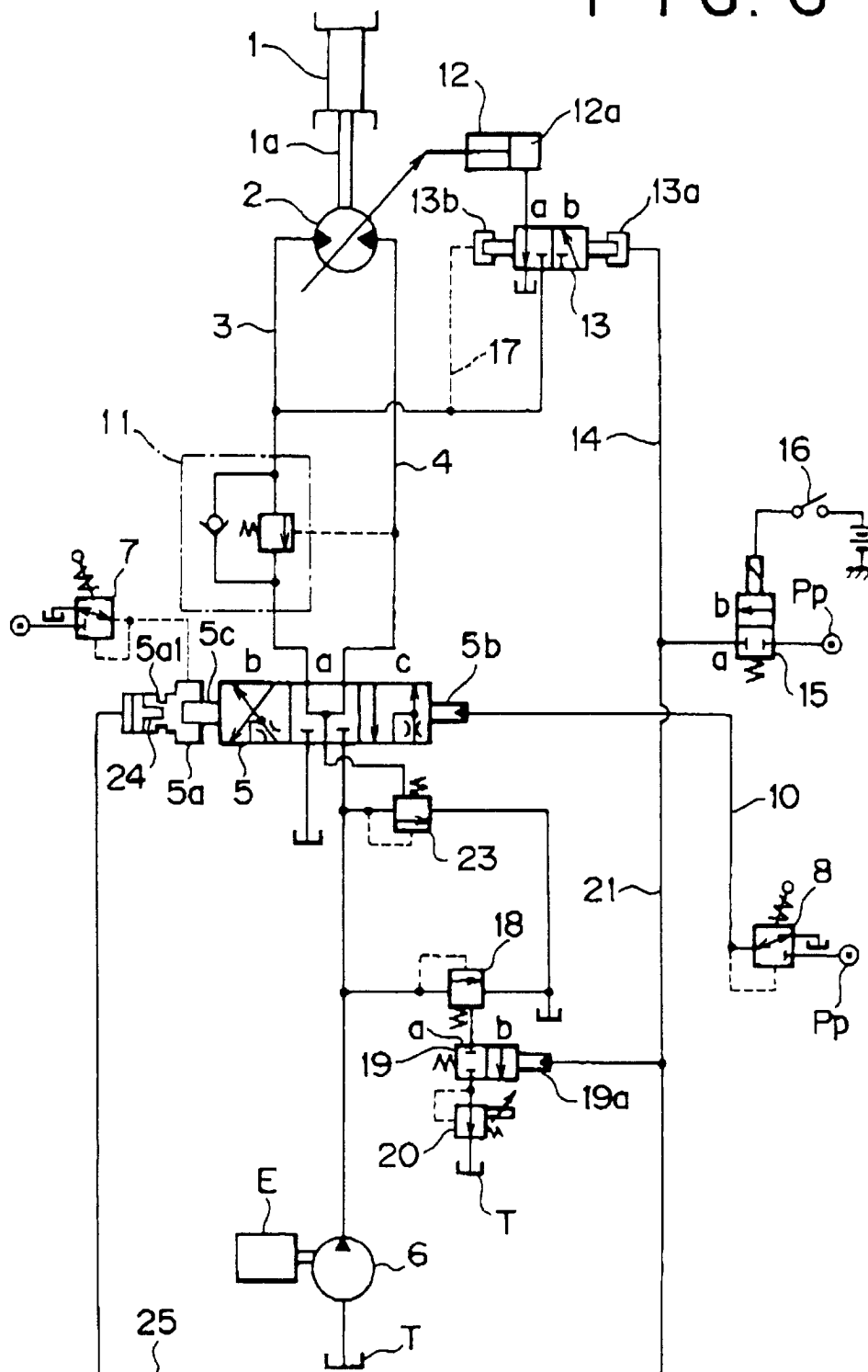


FIG. 7

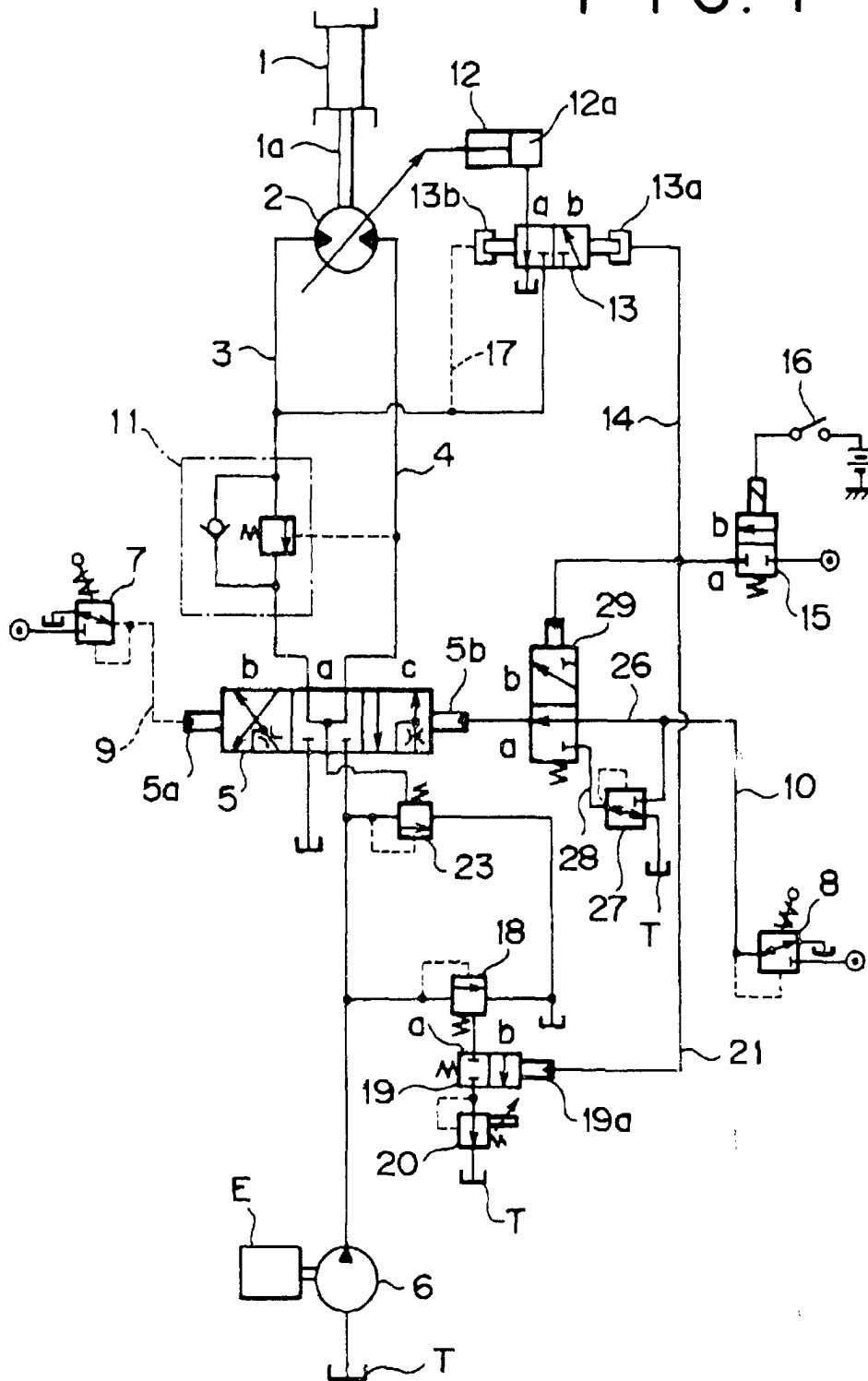


FIG. 8

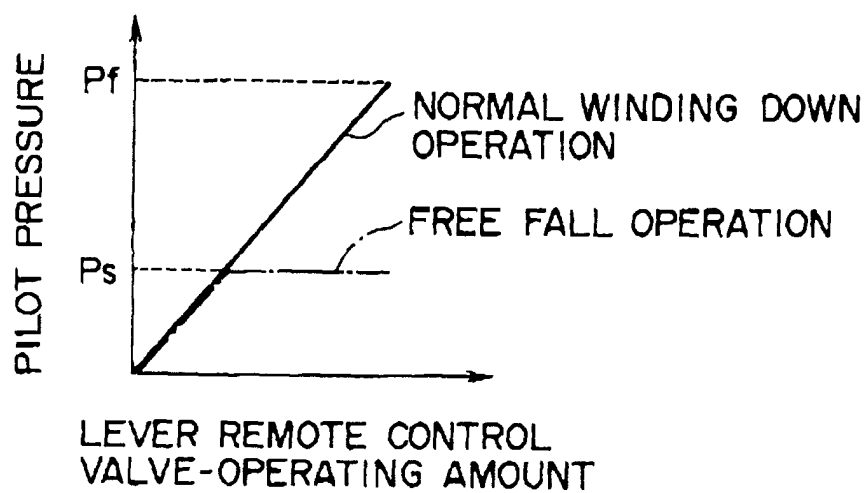
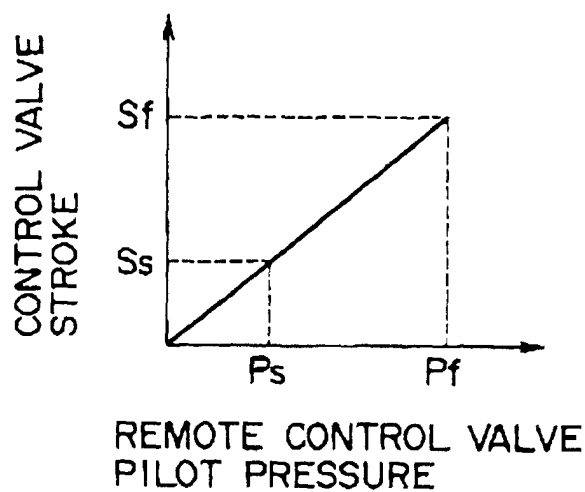


FIG. 9



F I G. 10

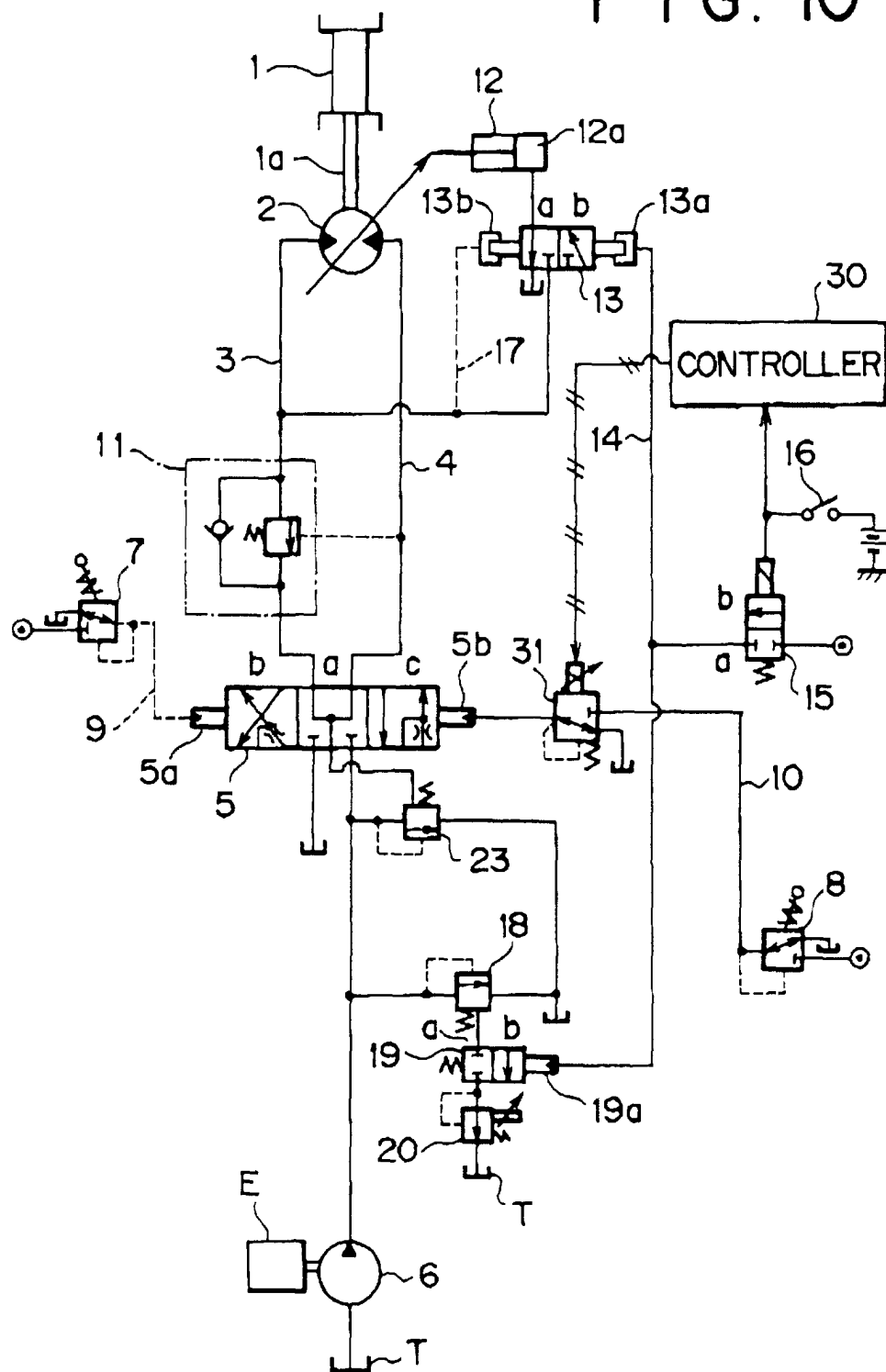


FIG. 11

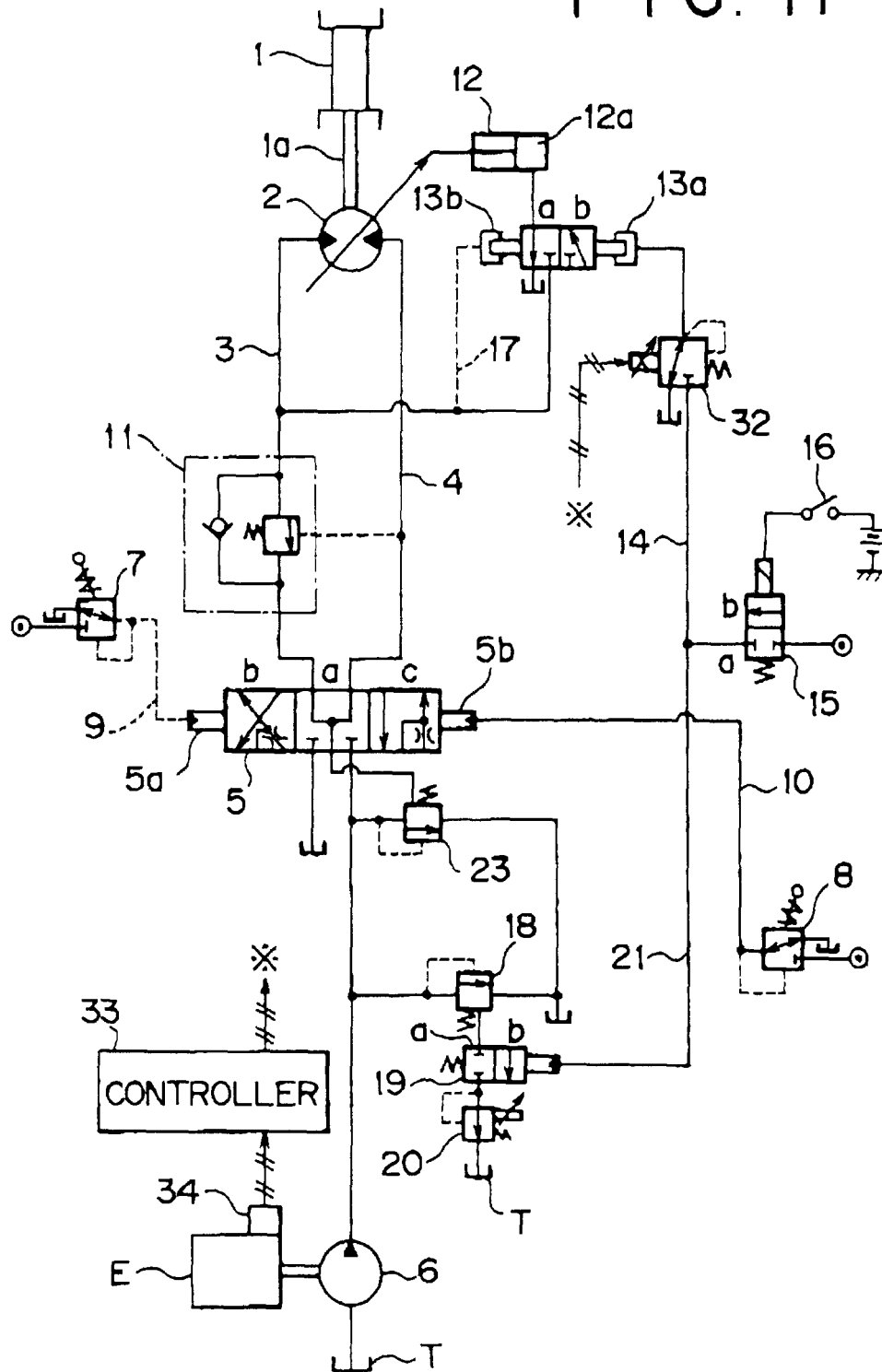


FIG. 12

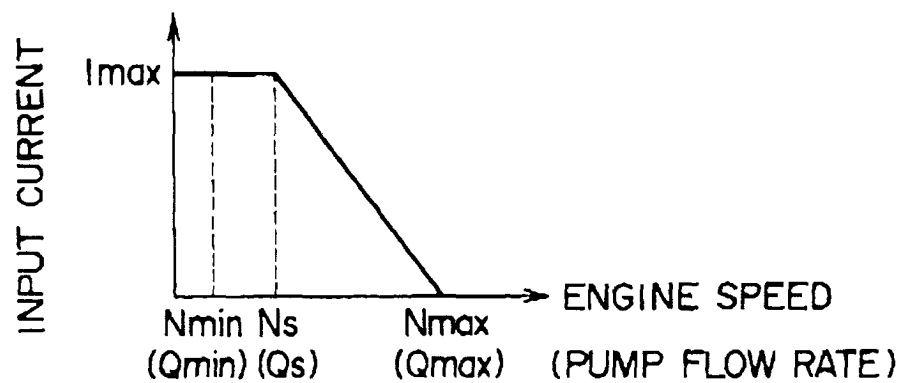


FIG. 13

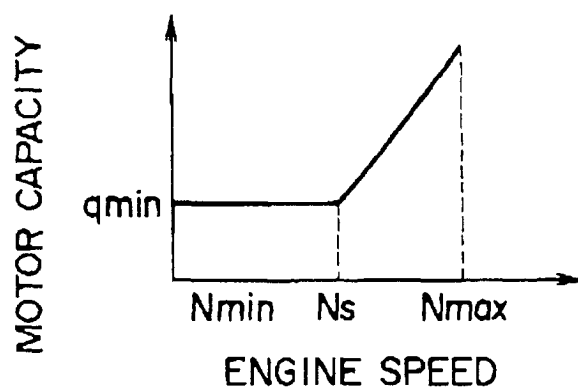


FIG. 14

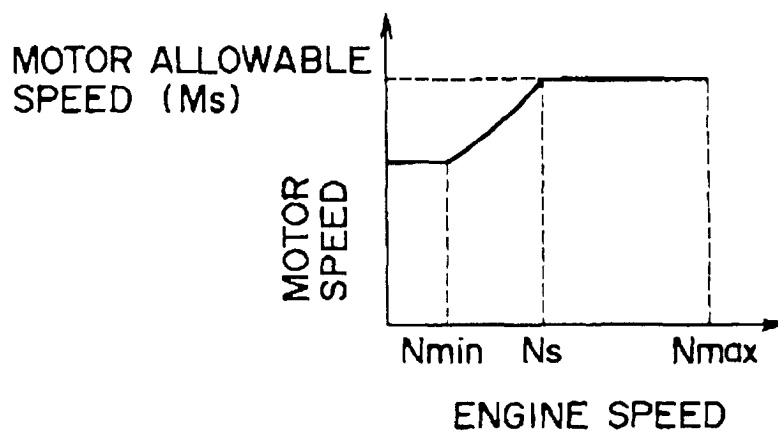


FIG. 15

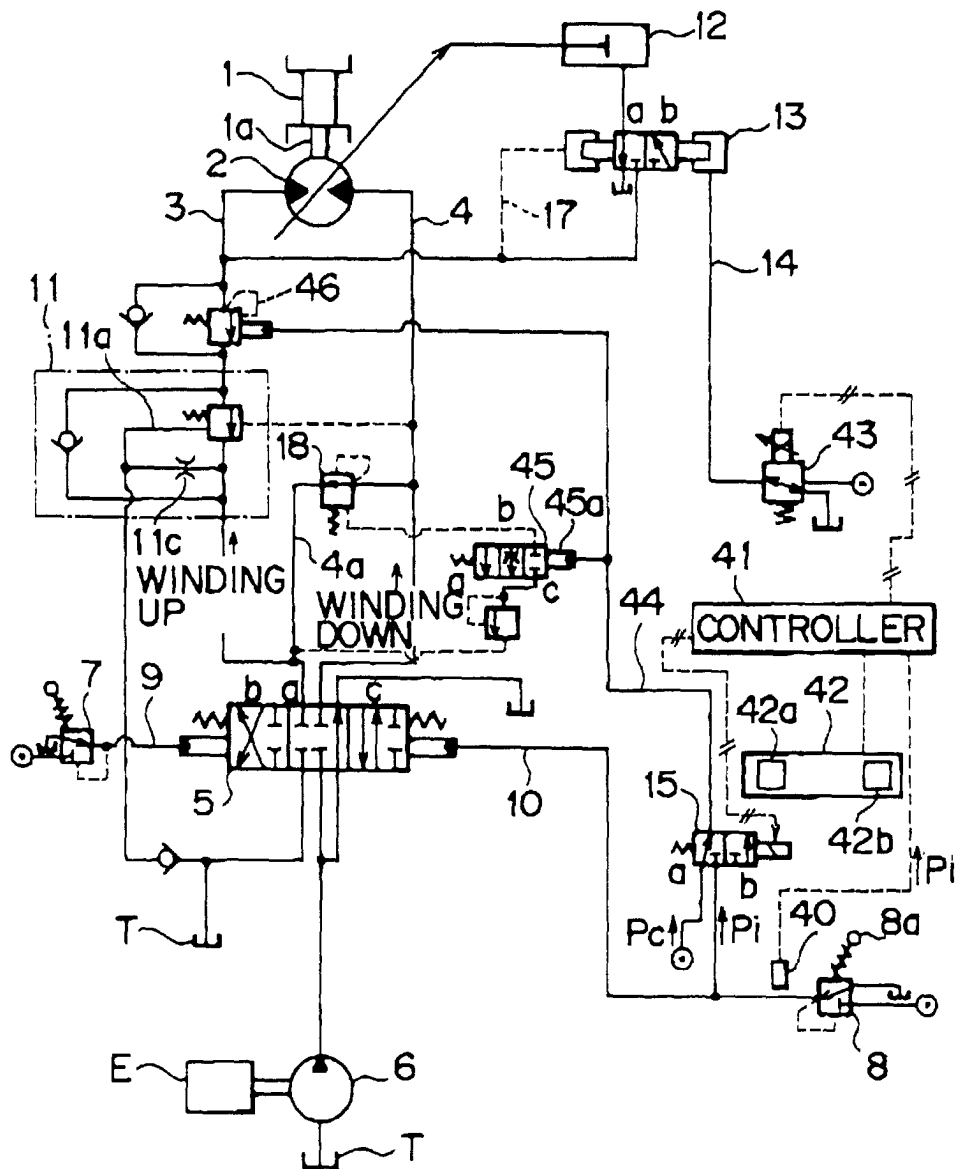
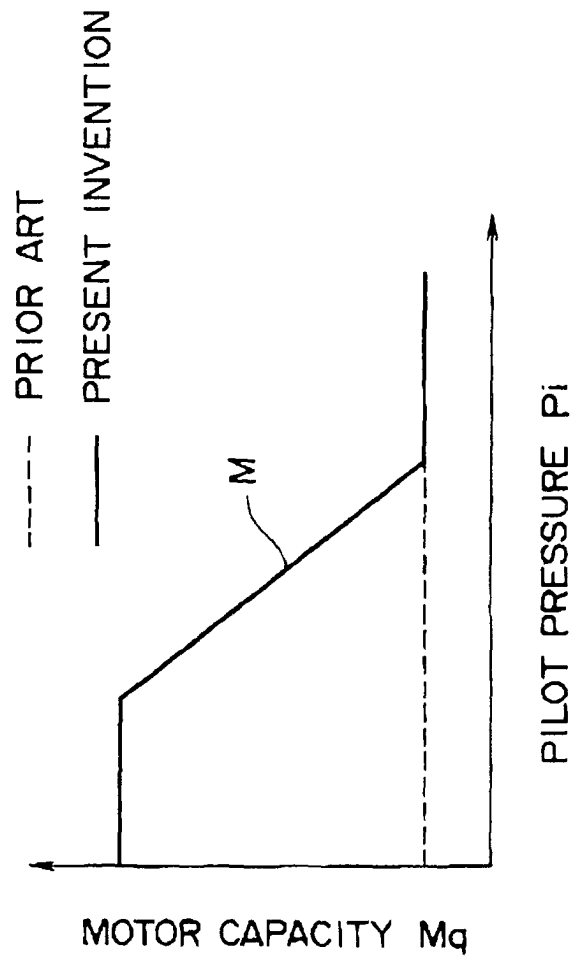


FIG. 16



RELATION BETWEEN PILOT PRESSURE AND MOTOR CAPACITY

- - - - - PRIOR ART
 ——— PRESENT INVENTION

FIG. 17A

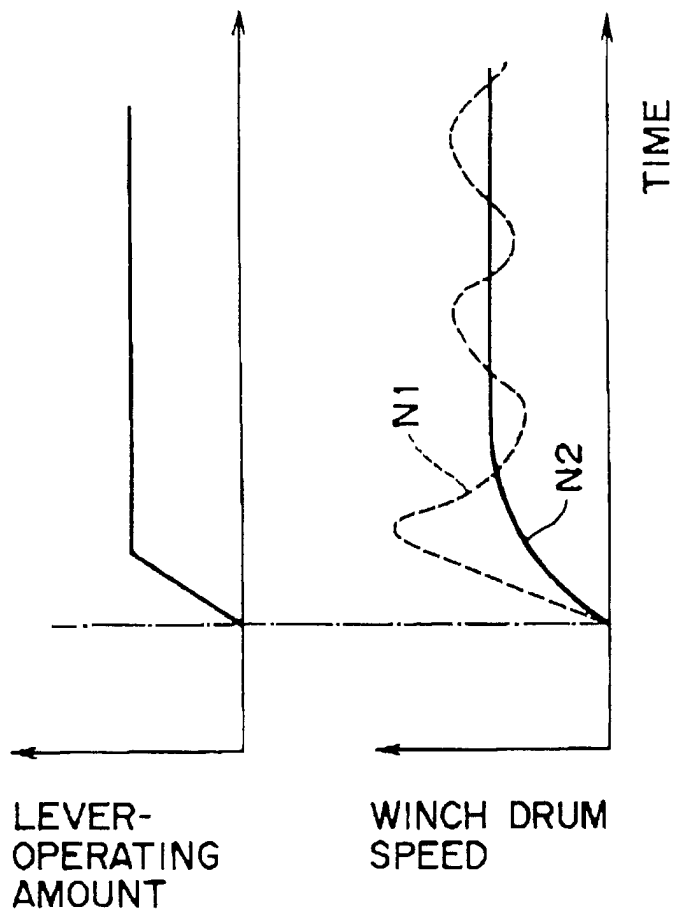


FIG. 17B

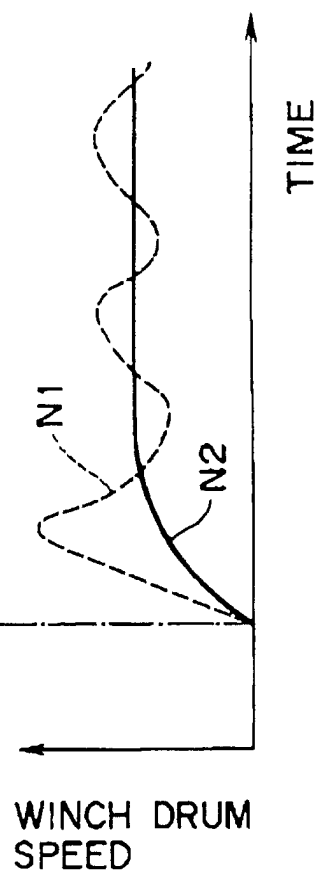


FIG. 18

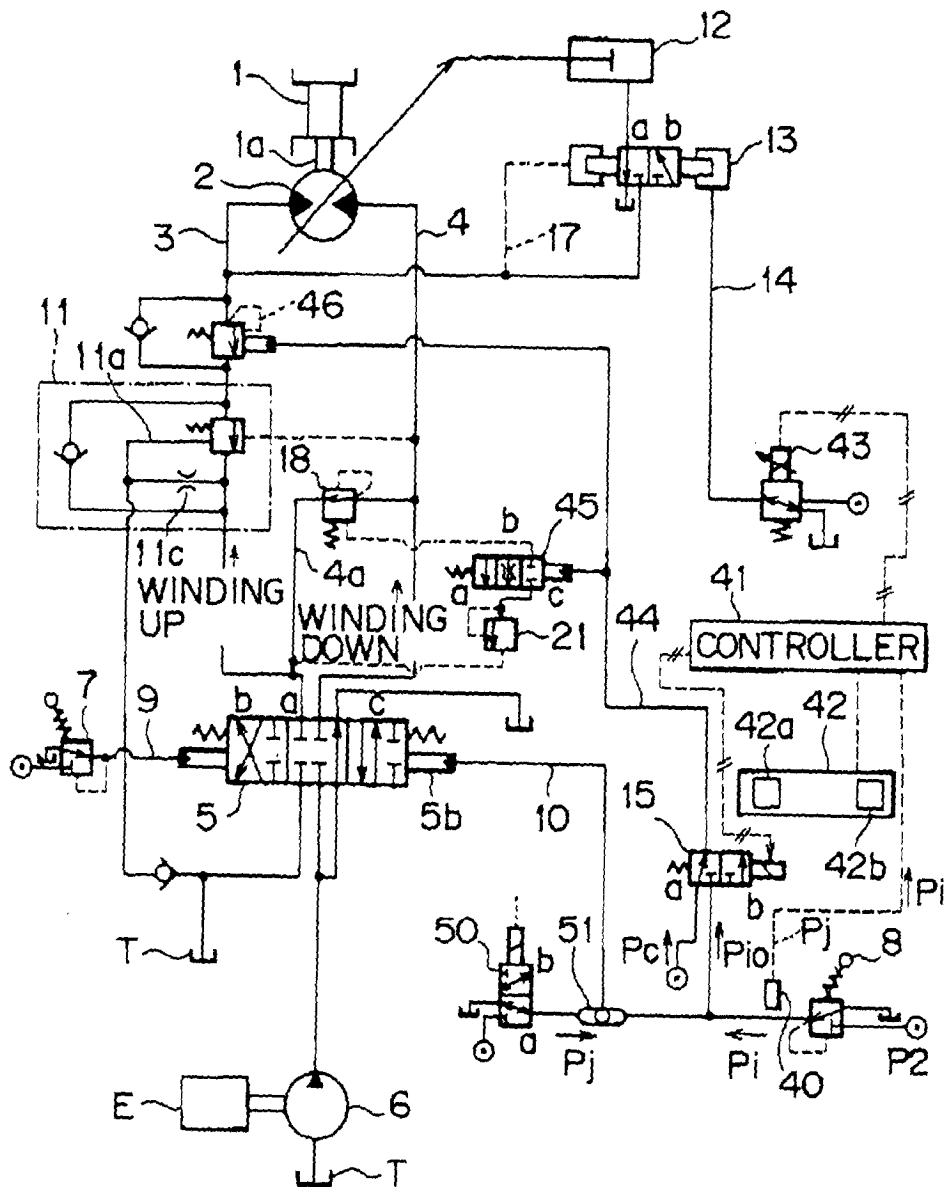


FIG. 19

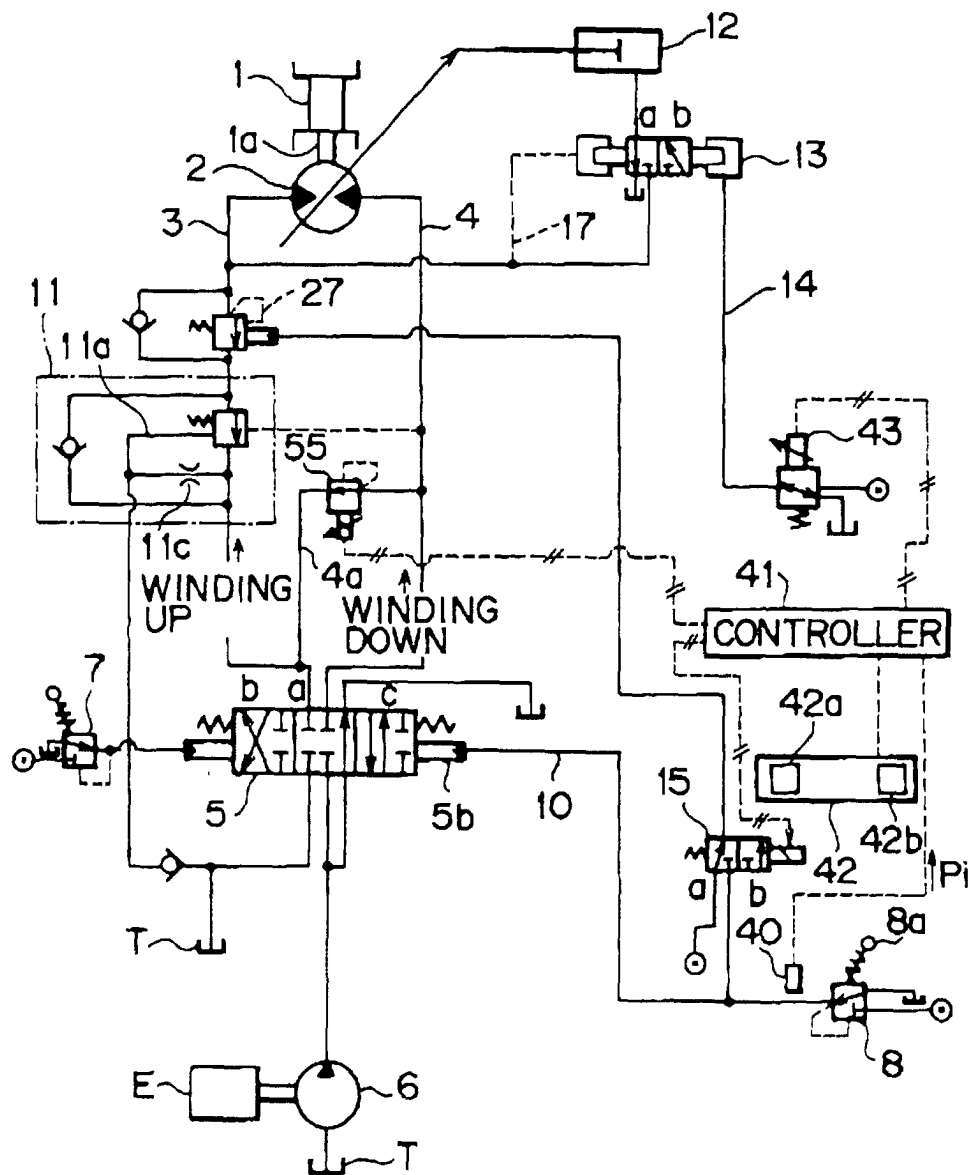


FIG. 20

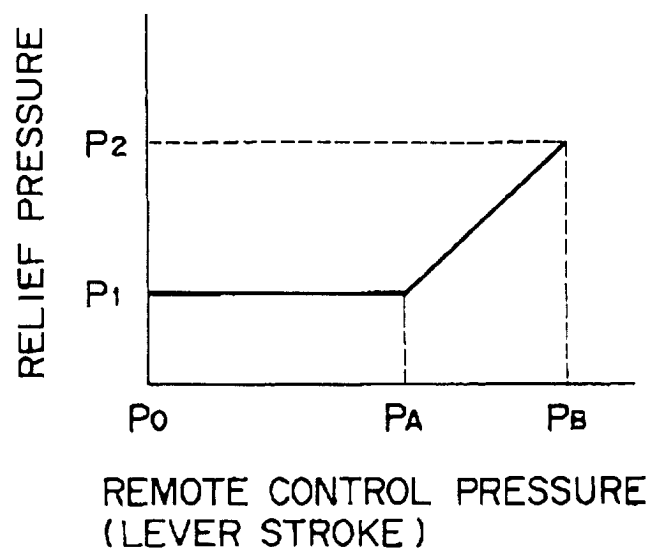
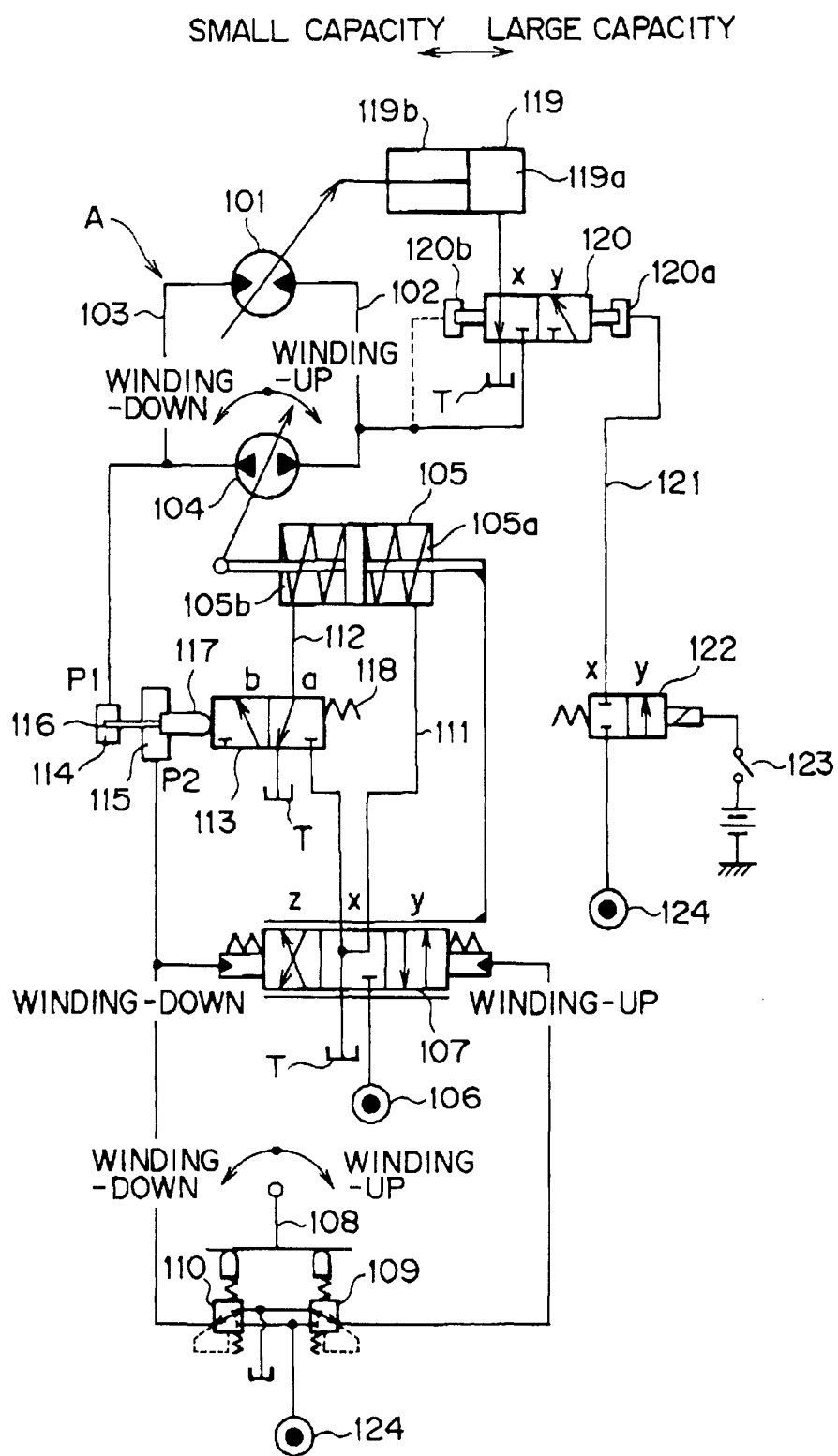
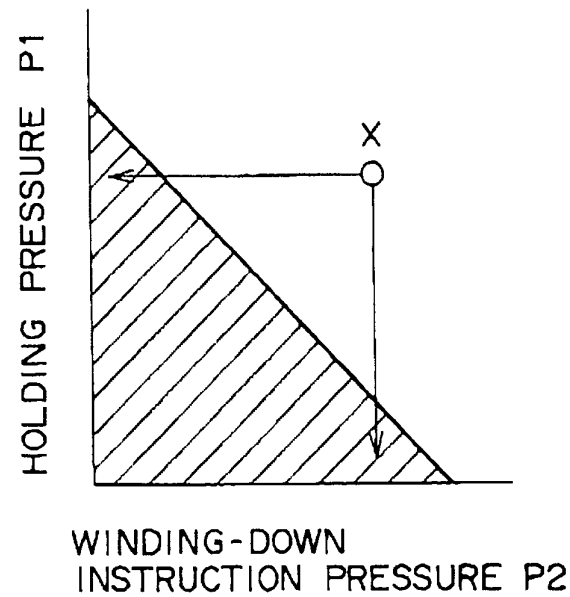


FIG. 21



F I G. 22



F I G. 23

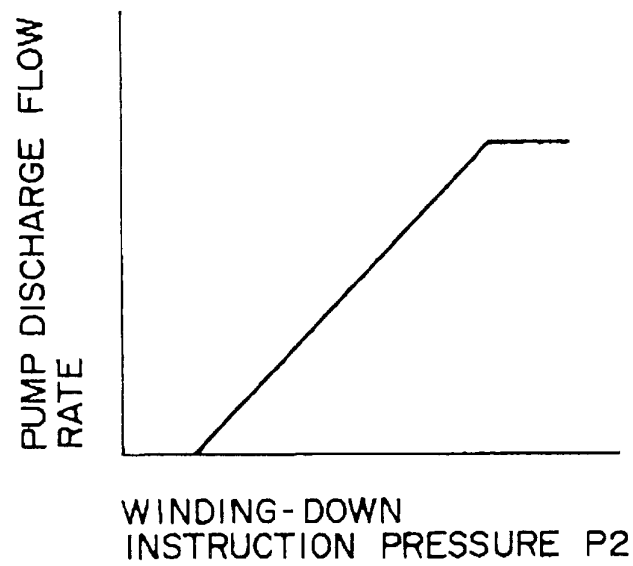


FIG. 24

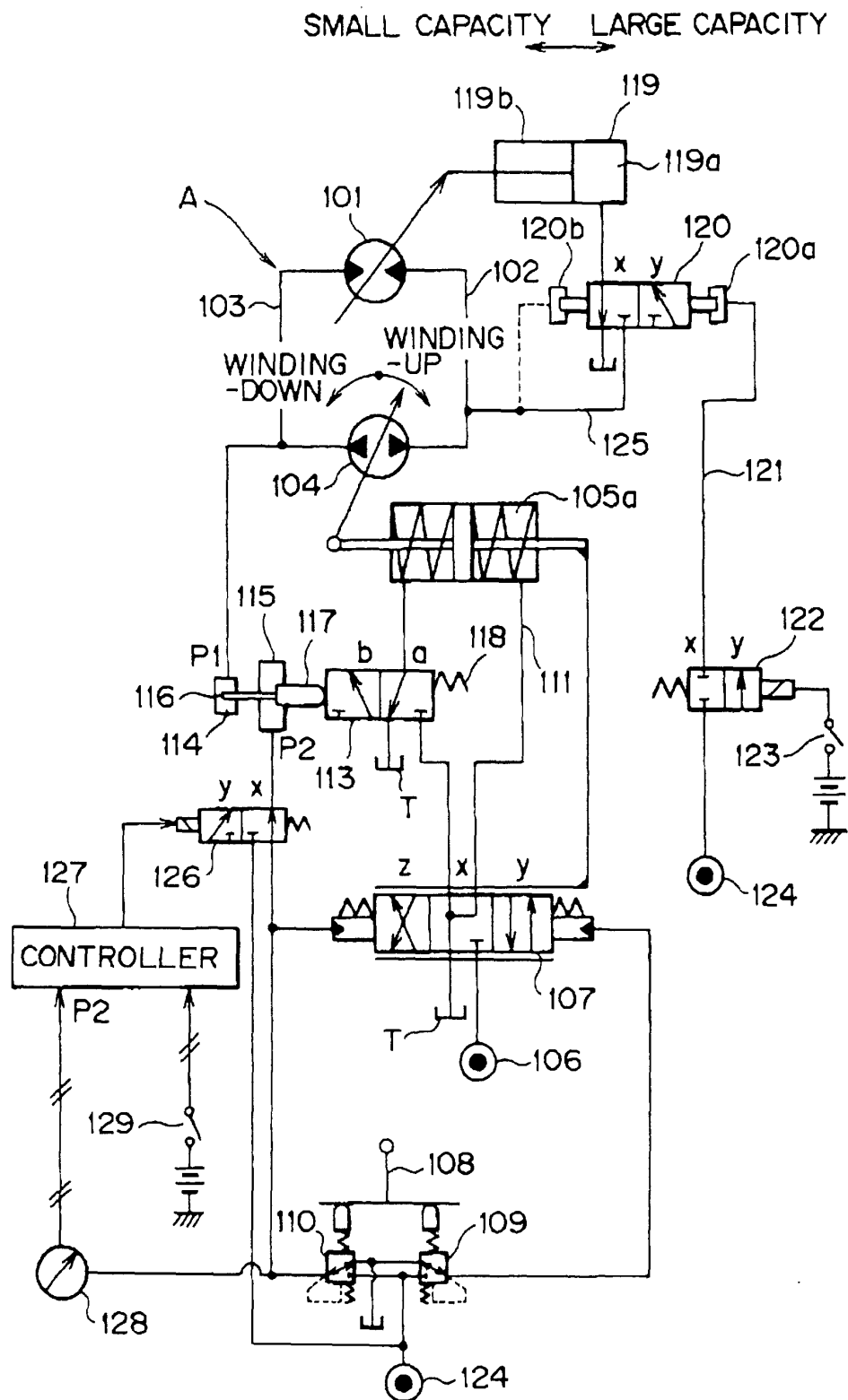


FIG. 25

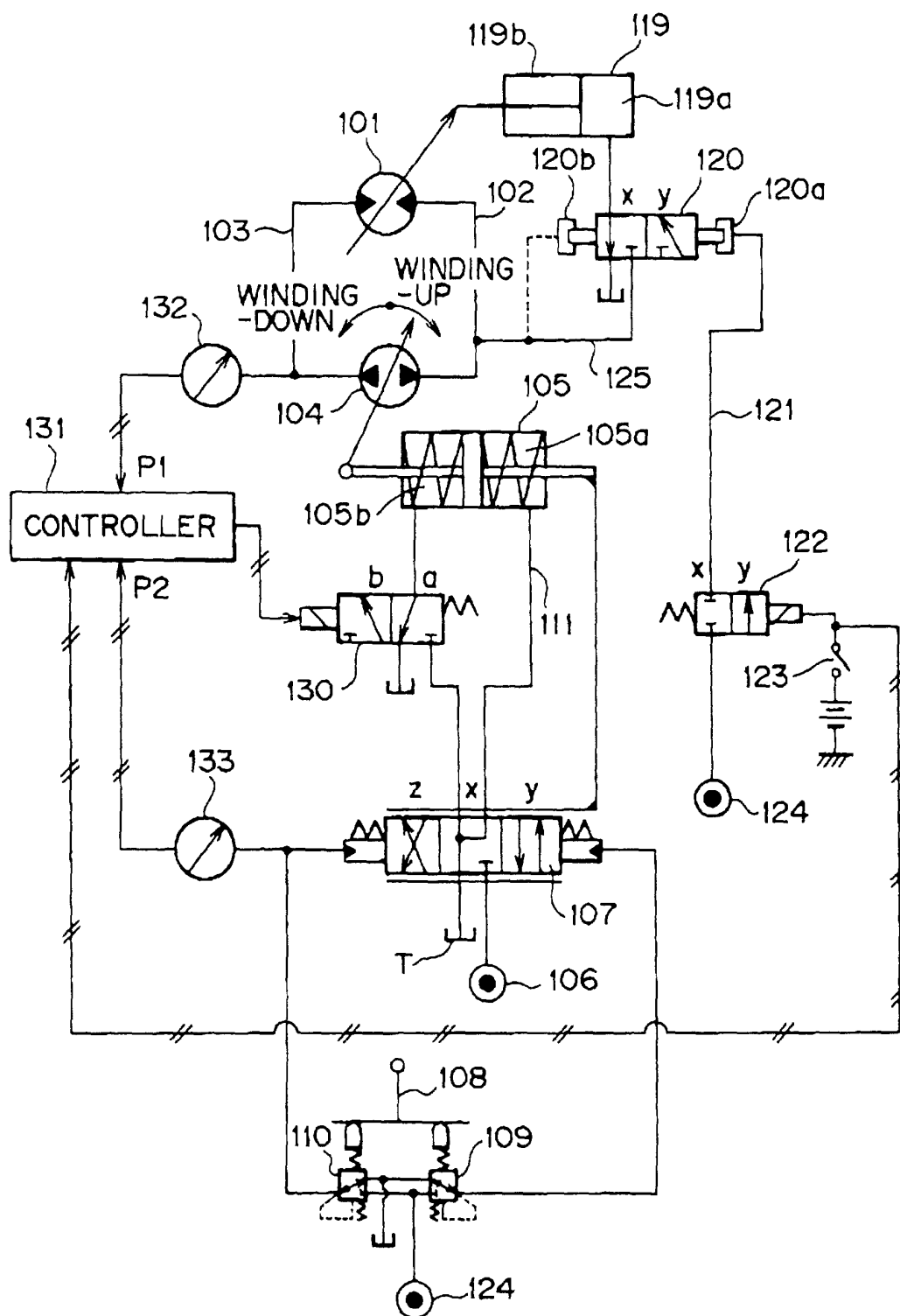
SMALL CAPACITY LARGE CAPACITY
←————→

FIG. 26

