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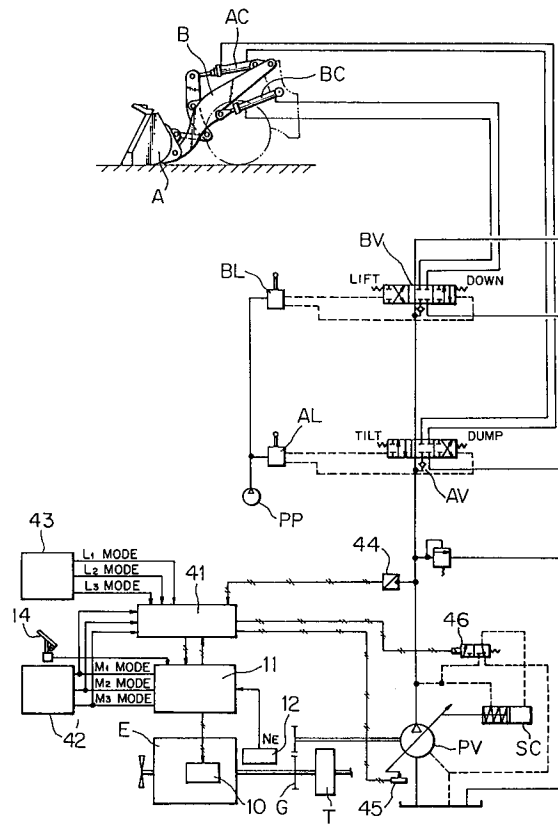
54 **METHOD AND UNIT FOR CONTROLLING VEHICLE FOR LOADING OPERATION.**

57 A method and a unit for controlling a vehicle for loading operation which carries a variable capacity hydraulic pump (PV) for operating a loading machine and a torque converter (T) for driving itself. The control unit comprises an engine (E) provided with an electronically controlled governor (10) capable of selecting output characteristics stepwise; means (12), (14), (42) and (43) for setting stepwise the maximum capacity and output torque of the variable-capacity hydraulic pump (PV) for operating the loading machine; means (44), (45) for detecting a pump capacity and hydraulic pressure; switches (42), (43) for selecting output characteristics of the

engine; a governor controller (11) for controlling to the output characteristics selected by the selecting switches; and a pump controller (41) for selectively setting the maximum capacity and output torque characteristics of the variable-capacity hydraulic pump (PV) in accordance with the engine output characteristics selected by the selecting switches. Accordingly, even if the hydraulic torque fluctuates at the time of high pressure in the variable-capacity hydraulic pump, the fluctuating range of absorption torque of the torque converter can be controlled, thereby enabling, to perform earth-sand scoop-up working with ease and efficiently.

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FIG. 1



## TECHNICAL FIELD

The present invention relates to a unit and a method for controlling a construction vehicle mainly for loading work such as a wheel loader, etc.

## BACKGROUND TECHNOLOGY

A conventional control system of a unit for controlling a wheel loader mainly for loading work is illustrated in Fig. 7. With reference to the figure, the engine E is controlled by way of a governor gv through a linkage li by operating an accelerating pedal ap. The output of the engine E is transmitted to a torque converter T and a gear G and the output transmitted to the gear G drives a variable capacity hydraulic pump P. The variable capacity hydraulic pump P controls a variable capacity hydraulic pump control valve pc by way of a servo cylinder SC so as to control the amount of oil under pressure. When a bucket operation pilot valve AL is operated to actuate a bucket main operation valve AV to thereby turn a bucket A by way of a bucket cylinder AC, so that the bucket A tilts rearward or dumps forward. When a boom operation pilot valve BL is operated to actuate a boom main operation valve BV to thereby turn a boom B by way of a boom cylinder BC, the boom B lifts upward or lowers downward. Designated at PP is a pilot pump.

The pressure versus flow rate characteristic diagram of the variable capacity hydraulic pump in the conventional control system of a loading machine is illustrated in Fig. 8. As is obvious from the figure, the hydraulic pump torque at high pressure can be limited to a necessary and sufficient amount by varying the flow rate Q according to the pump discharge hydraulic pressure P corresponding to the maximum hydraulic pump torque  $T_{X1}$  or  $T_{X2}$ . However, in a vehicle in which the output of the engine E is distributed to the hydraulic pump PV and the power transmission device of the driving mechanism (torque converter T) as illustrated in Figs. 7 and 8, there was a serious problem that the reduced amount of power consumed by the hydraulic pump PV was absorbed by the driving mechanism so that the driving power was increased by the reduced amount and the ratio of the output to the driving mechanism relative to that to the loading machine was increased, which deteriorated the operability of a vehicle for earth-sand scoop-up working, etc. as illustrated in Fig. 9. That is, referring to Figs. 8 and 9;

(1) when the hydraulic torque characteristic of the loading machine pump is reduced from  $T_{X1}$  to  $T_{X2}$ , contrariwise the absorption torque of the torque converter is increased from  $T_{tx1}$  to  $T_{tx2}$ , so that the distribution between the hydraulic

output and the driving output is inverted.

(2) When the hydraulic pressure in the loading machine gets high, the hydraulic pump torques are decreased from  $T_{X1}$  and  $T_{X2}$  corresponding to the points  $X_1$  and  $X_2$  to  $T_Y$  corresponding to the point Y, so that the absorption torques of the torque converter are increased from  $T_{tx1}$  and  $T_{tx2}$  to  $T_{ty}$  and the driving force becomes excessive.

It is the object of the present invention to solve the aforementioned problems.

## DISCLOSURE OF THE INVENTION

To achieve the above object, the present invention provides a unit for controlling a vehicle for loading operation which carries a variable capacity hydraulic pump for operating a loading machine and a torque converter for driving itself, the control unit comprising an engine provided with an electronically controlled governor capable of selecting stepwise the output characteristic of the engine, electromagnetic changeover valves for setting stepwise the maximum capacity and the output torque of the variable capacity hydraulic pump, a pump capacity detector, an hydraulic pressure detector, a switch for selecting the output characteristics of the engine and the variable capacity hydraulic pump (hereinafter referred to M mode control switch), an electronic governor controller for controlling engine output characteristics and a variable capacity pump controller for selectively setting the maximum capacity and the output torque characteristics of the variable capacity hydraulic pump, so as to control the amounts and distribution of the hydraulic output and the driving output by selecting the M mode control switch for the improvement of operability. Furthermore, the control unit is equipped with a selective switch capable of selecting stepwise the cut-off pressure of the discharge flow of the variable capacity pump (hereinafter referred to L mode control switch). As a result, it is possible to select the distribution of power to the loading machine and driving mechanism by a matrix, i.e., the combination of the steps of the L mode control switch and the steps of the M mode control switch.

## BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a view showing the control system of a vehicle for loading work according to an embodiment of the present invention, Fig. 2 is a view for explaining the pressure versus flow rate characteristic curve of a variable capacity pump PV, Figs. 3(a), 3(b) and 3(c) are diagrams for explaining the distributions of power by a combination of  $M_1$  mode and  $L_1$  mode, by a combination of  $M_2$  mode

and L<sub>2</sub> mode and by a combination of M<sub>3</sub> mode and L<sub>3</sub> mode respectively, Figs. 4(a) and 4(b) respectively shows flowcharts of the control method of loading machine according to the present invention, Fig. 5 is a diagram for explaining a control method for reducing the setting of an engine torque in response to a hydraulic torque, Figs 6(a) and 6(b) are views for explaining the power distribution matrix of the loading machine hydraulic pressure L and the driving force M and Figs. 7, 8 and 9 are diagrams for explaining a conventional control unit.

#### BEST MODE FOR CARRYING OUT THE INVENTION

An embodiment of the present invention will be described with reference to drawings.

Fig. 1 is a block diagram showing the control system of a vehicle for loading work according to an embodiment of present invention wherein elements which operate in the same way as the conventional system as explained in Fig. 7 are denoted at the same numerals.

An engine E has an electronically controlled governor 10 which is mounted thereon and is capable of optionally selecting output characteristics stepwise and an electronic governor controller 11 is provided for controlling the electronically controlled governor 10 in response to input signals (1) to (4) set forth hereunder.

(1) a signal representing an engine speed N<sub>E</sub> issued by a rotary sensor 12 provided on the gear G

(2) a control signal of the variable capacity pump PV issued by a variable capacity pump controller 41 (the electronic governor controller 11 receives the control signal as an input signal and issues information signals to the variable capacity pump controller 41)

(3) a stepping amount signal  $\theta_A$  issued by an accelerator pedal 14

(4) M mode selection signal issued by the M mode control switch 42

The variable capacity pump controller 41 receives signals from and sends signals to the electronic governor controller 11 and outputs a signal to an electromagnetic pilot valve 46 to thereby selectively switch the electromagnetic pilot valve 46.

(5) M mode selection signals issued by the M mode control switch 42

(6) L mode selection signals issued by the L mode control switch 43

(7) hydraulic pressure signal issued by a pump capacity detector 44 provided at the discharge side of the variable capacity pump PV for detecting the hydraulic pressure

(8) a signal representing the discharged amount of oil under pressure issued by a pump capacity detector 45 for detecting the capacity of the variable capacity pump PV

An operation of the embodiment will be described hereinafter. (A) Fig. 2 shows the hydraulic pressure versus flow rate characteristic curves of the variable capacity pump PV according to an embodiment of the present invention. It is possible to set stepwise a plurality of M modes such as M1 mode, M2 mode and M3 mode by operating the M mode control switch 42 thereby to set the torque characteristics of the engine E as indicated by the engine torque curves at M1 mode, M2 mode and M3 mode by way of the electronically controlled governor 10, and it is possible to set stepwise the maximum hydraulic pressure of the loading machine in a plurality of L modes such as L1 mode, L2 mode and L3 mode by selectively setting the torque characteristic of the engine E in accordance with the setting of the M mode control switch 42 among those indicated by the engine torque curves of M1, M2 and M3 modes illustrated respectively in Figs. 3(a), 3(b) and 3(c) by way of the electronically controlled governor 10 and by operating the L mode control switch 43.

As a result, for example, in cases that M1 mode is combined with L1 mode, M2 mode is combined with L2 mode and L3 mode is combined with L3 mode respectively, the maximum torque points are B<sub>1</sub>, B<sub>2</sub> and B<sub>3</sub>, the hydraulic torques at the maximum torque points are T<sub>B1</sub>, T<sub>B2</sub> and T<sub>B3</sub> respectively and the absorption torque points of the torque converters at the maximum torque points are B<sub>1</sub>', B<sub>2</sub>' and B<sub>3</sub>' respectively as illustrated in Figs. 3(a), 3(b) and 3(c), so that it is possible to conform the order in strength of hydraulic torques, i.e., T<sub>B1</sub> > T<sub>B2</sub> > T<sub>B3</sub> to the order in strength of driving forces (absorption torques of the torque converter), i. e., (torque at B<sub>1</sub>') > (torque at B<sub>2</sub>') > (torque at B<sub>3</sub>'). (B) When the pressure of the variable capacity pump PV is high (more than P<sub>A</sub> according to this embodiment) and the hydraulic torque is not proportional to the hydraulic pressure as illustrated in Fig. 2, the maximum engine speeds of the engine E (the regulation of an all-speed governor) are changed from N<sub>C1</sub>, N<sub>C2</sub> and N<sub>C3</sub> to N<sub>C1</sub>', N<sub>C2</sub>' and N<sub>C3</sub>' by the electronically controlled governor 10 so as to reduce the variation of the absorption torque of the torque converter as illustrated in Figs. 3(a), 3(b) and 3(c). For example, in the embodiment illustrated in Fig. 2 and Figs. 3(a), 3(b) and 3(c), the maximum engine speeds are changed when the hydraulic torques of the hydraulic pressure P<sub>A</sub> are around T<sub>A1</sub>, T<sub>A2</sub> and T<sub>A3</sub>, and the absorption torques of the torque converter are A<sub>1</sub>', A<sub>2</sub>' and A<sub>3</sub>' respectively when the hydraulic torques are T<sub>A1</sub>, T<sub>A2</sub> and T<sub>A3</sub>. The absorp-

tion torques of the torque converter at the points  $A_4$ ,  $A_5$ ,  $A_5'$ ,  $B_4$ ,  $B_5$  and  $B_6$  on a curve having a same hydraulic pressure in Fig. 2 are respectively changed to those at the points  $A_4'$ ,  $A_5'$ ,  $A_5'$ ,  $B_4'$ ,  $B_5'$  and  $B_6'$  in Figs. 3(a), 3(b) and 3(c). In this way, it is possible to suppress the variation of the absorption torque of the torque converter as represented by  $B_4'$ ,  $B_5'$  and  $B_6'$  in Figs. 3(a), 3(b) and 3(c) even if the hydraulic torque is varied when the pressure of the variable capacity hydraulic pump PV is high, so that it is possible to prevent the excessive increase of driving force in earth-sand scoop-up work.

An operation of the control method will be described with reference to the flowcharts illustrated in Figs. 4(a) and 4(b). Fig. 4(a) shows a control flowchart of the electronically controlled governor 10 for reducing the set maximum engine speed when the loading machine hydraulic pressure is more than  $P_{A1}$  (or  $P_{A2}$  or  $P_{A3}$ ), the capacity of the pump is cut off and the hydraulic torques are under  $T_{A1}$  (or  $T_{A2}$  or  $T_{A3}$ ), while Fig. 4(b) shows a control flowchart for controlling the target engine speed according to the loading machine hydraulic pressure when the hydraulic pressure of the loading machine is more than  $P_{B1}$  (or  $P_{B2}$  or  $P_{B3}$ ), the capacity of the pump is cut off and the hydraulic torques are under  $T_{B1}$  (or  $T_{B2}$  or  $T_{B3}$ ).

The same effect can be obtained by reducing the engine torque in accordance with the hydraulic torque of the variable capacity hydraulic pump PV.

It will be described with reference to Fig. 5. When the discharge hydraulic pressure of the pump is more than  $P_A$  and the hydraulic torque is reduced under  $T_{A1}$ , for example, when the engine torque is reduced by  $k(T_{A1} - T_{B4})$  in case of the hydraulic torque  $T_{B4}$  ( $= T_{A4}$ ) of the point  $B_4$  in Fig. 2, the point  $A_4'$  can be moved to the point  $B_4'$ . (C) Since the variation of absorption torque of the torque converter under the high hydraulic pressure of the loading machine is reduced, the order in strength of the hydraulic torque is conformed to that of the driving torque by way of the engine output selection means and the cut-off pressure of the discharged flow rate of the variable capacity pump PV is stepwise selectable, it is possible to select the distribution of power by a matrix, i.e., the combination of the hydraulic pressures of the loading machine L1, L2 and L3 which are selected by way of loading machine hydraulic pressure selection means and the driving forces M1, M2 and M3 which are stably selected by way of engine output selection means as illustrated in Fig. 6(a). Fig. 6(b) is a view for explaining the operation of the loading machine hydraulic pressure L and the driving force M.

## INDUSTRIAL UTILIZATION

With the arrangement as set forth above in detail, even if the hydraulic torque varies when the pressure of the variable capacity hydraulic pump is high the fluctuation range of absorption torque of the torque converter can be suppressed, thereby preventing the excessive increase of the driving force in earth-sand scoop-up work and enabling to perform the scoop-up working with ease and efficiency.

The present invention has also a great effect that it can correspond to various working conditions with ease since the distribution of power between the loading machine and driving mechanism can be selected by matrix, i.e., a combination of two variables.

## Claims

1. A unit for controlling a vehicle for loading operation which carries a variable capacity hydraulic pump for operating a loading machine and a torque converter for driving itself, characterized in that the control unit comprises:
  - an engine provided with an electronically controlled governor capable of selecting output characteristic thereof stepwise;
  - means for setting stepwise the maximum capacity and output torque of the variable capacity hydraulic pump for operating the loading machine;
  - means for detecting the capacity and hydraulic pressure of the variable capacity hydraulic pump;
  - switches for selecting output characteristics of the engine;
  - a governor controller for controlling to the output characteristics selected by said selecting switches; and
  - a pump controller for optionally setting the maximum capacity and output torque characteristics of the variable capacity hydraulic pump in accordance with the engine output characteristics selected by said selecting switches.
2. A method for controlling the engine and the variable capacity hydraulic pump of a loading work vehicle applied by the control unit according to claim 1, characterized in that the set maximum number of revolution of said electronically controlled governor (regulation characteristics) or the set engine torque is reduced according to the discharge hydraulic pressure or the output hydraulic torque of the variable capacity hydraulic pump.

3. A method for controlling the variable capacity hydraulic pump for a loading work vehicle applied by the control unit according to claim 1, characterized in that the control unit comprises a switch capable of optionally setting the cut-off pressure of the discharge flow of the variable capacity hydraulic pump so that the discharge flow rate versus discharge pressure characteristics of the variable capacity hydraulic pump PV is set stepwise by said cut-off pressure selecting switch and said maximum capacity and output torque selecting switch.

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FIG. 1

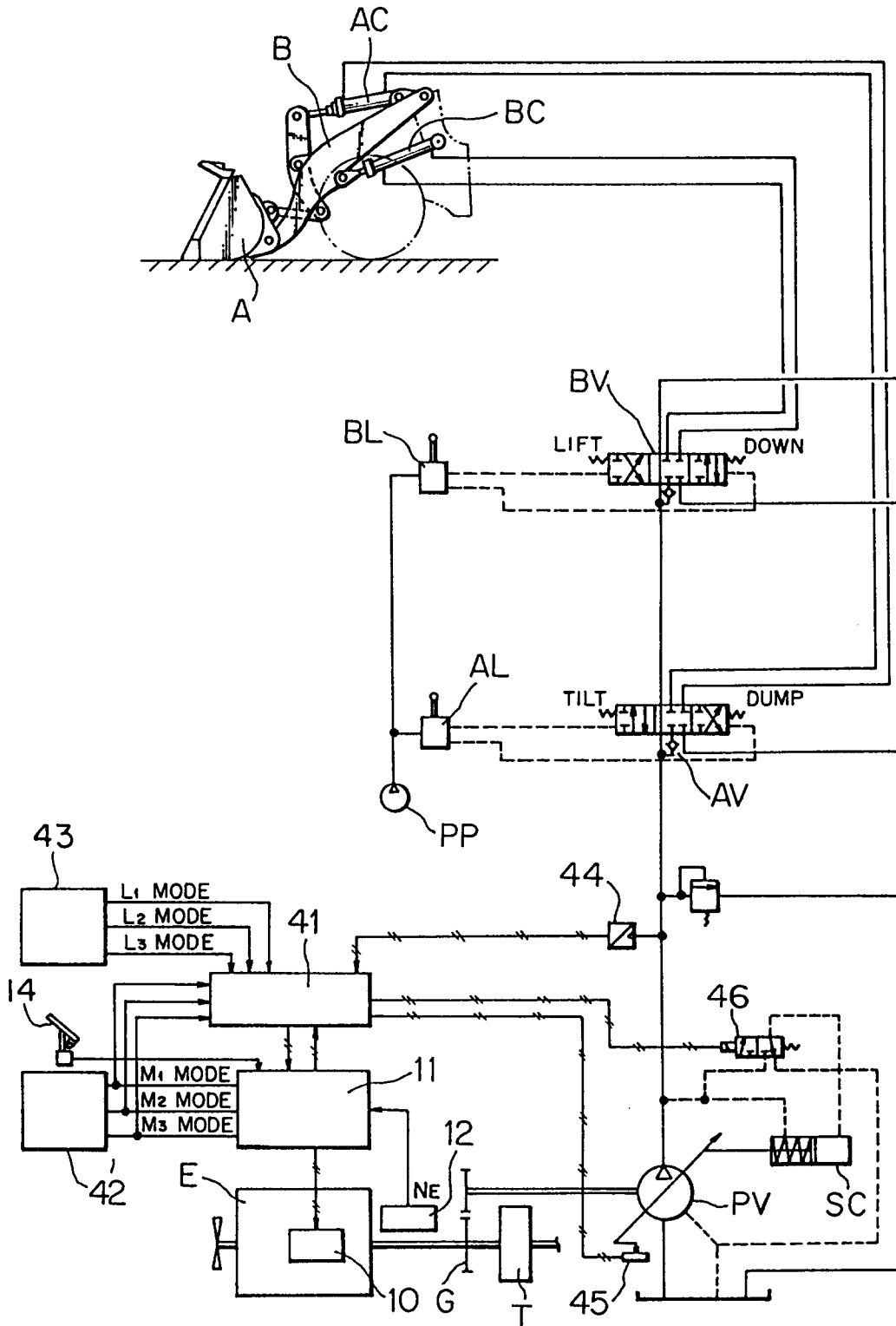


FIG. 2

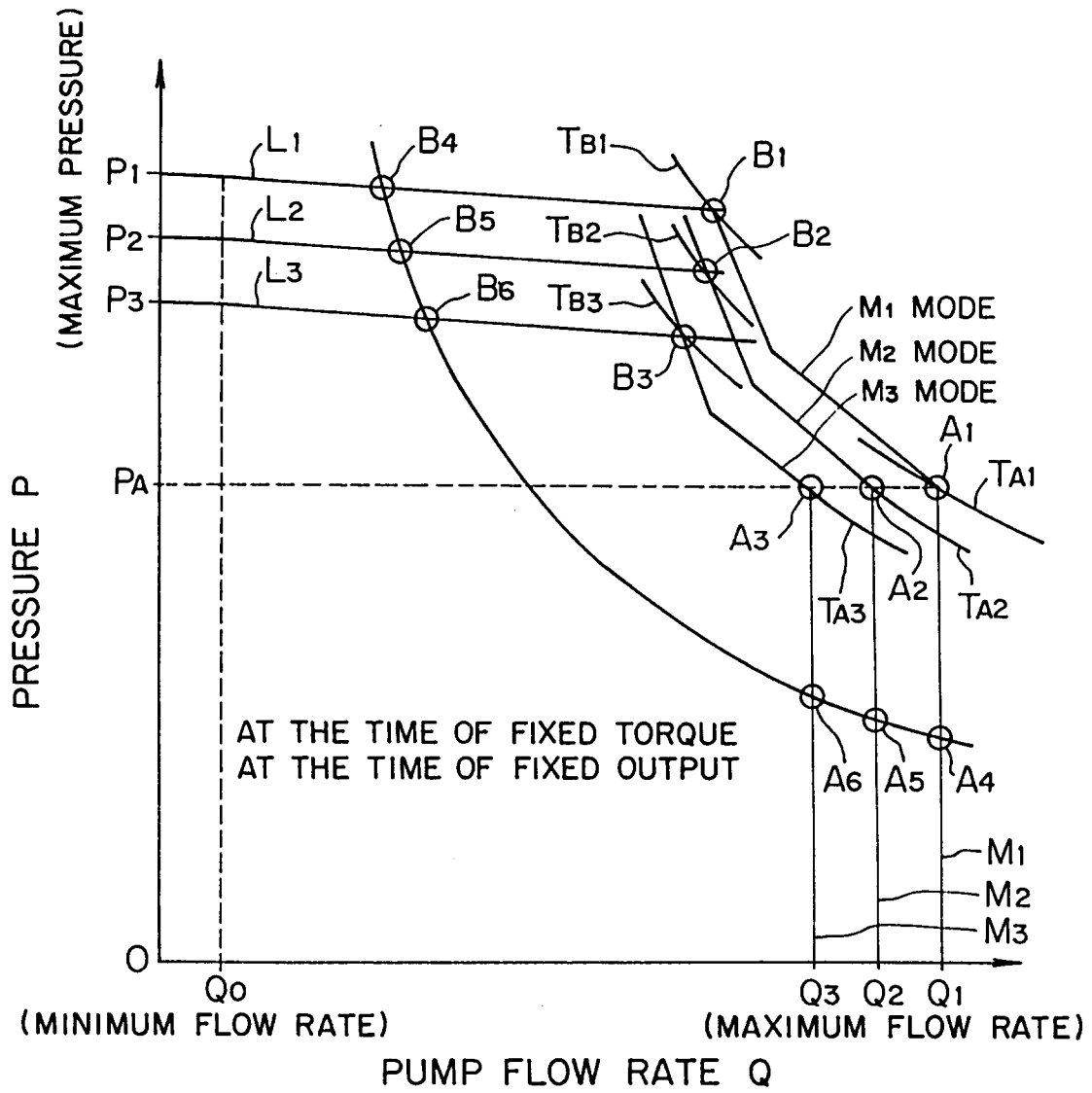


FIG. 3 (a)

[M1 MODE & L1 MODE]

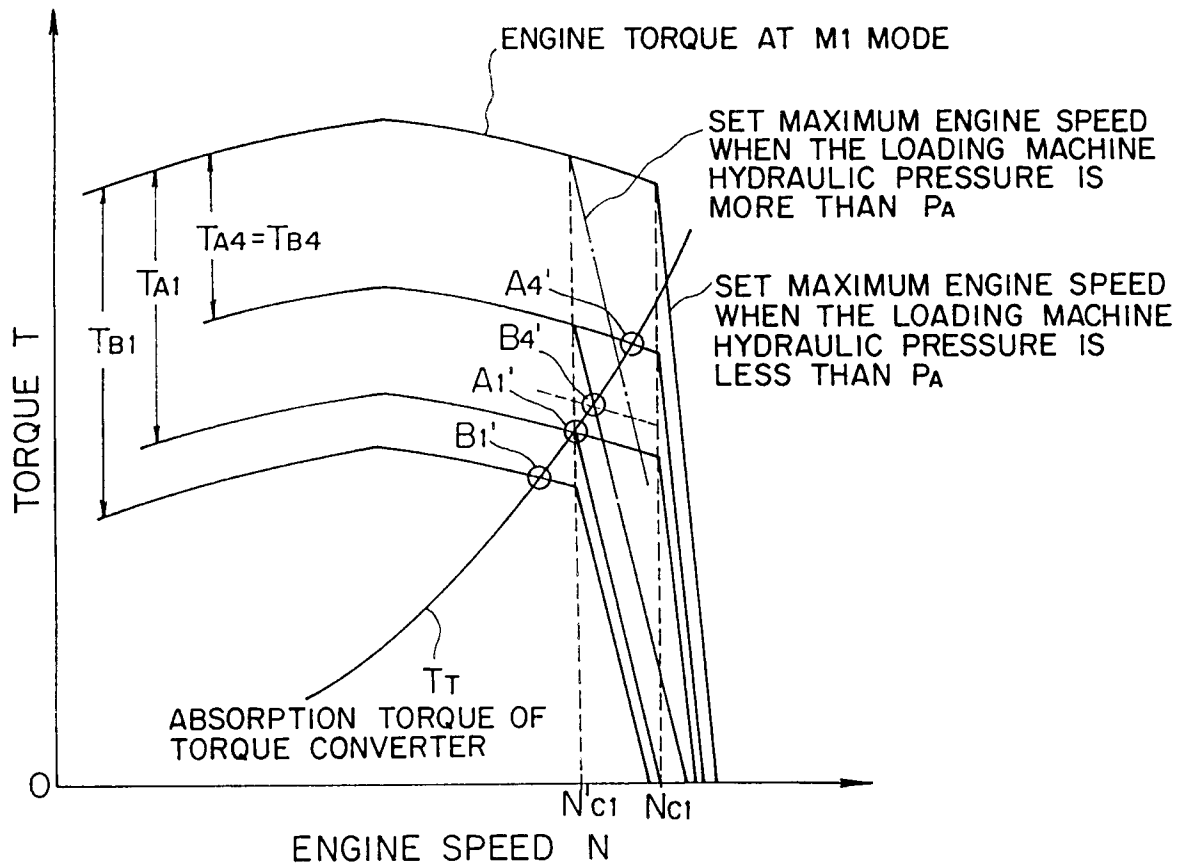


FIG.3(b)

[M2 MODE & L2 MODE]

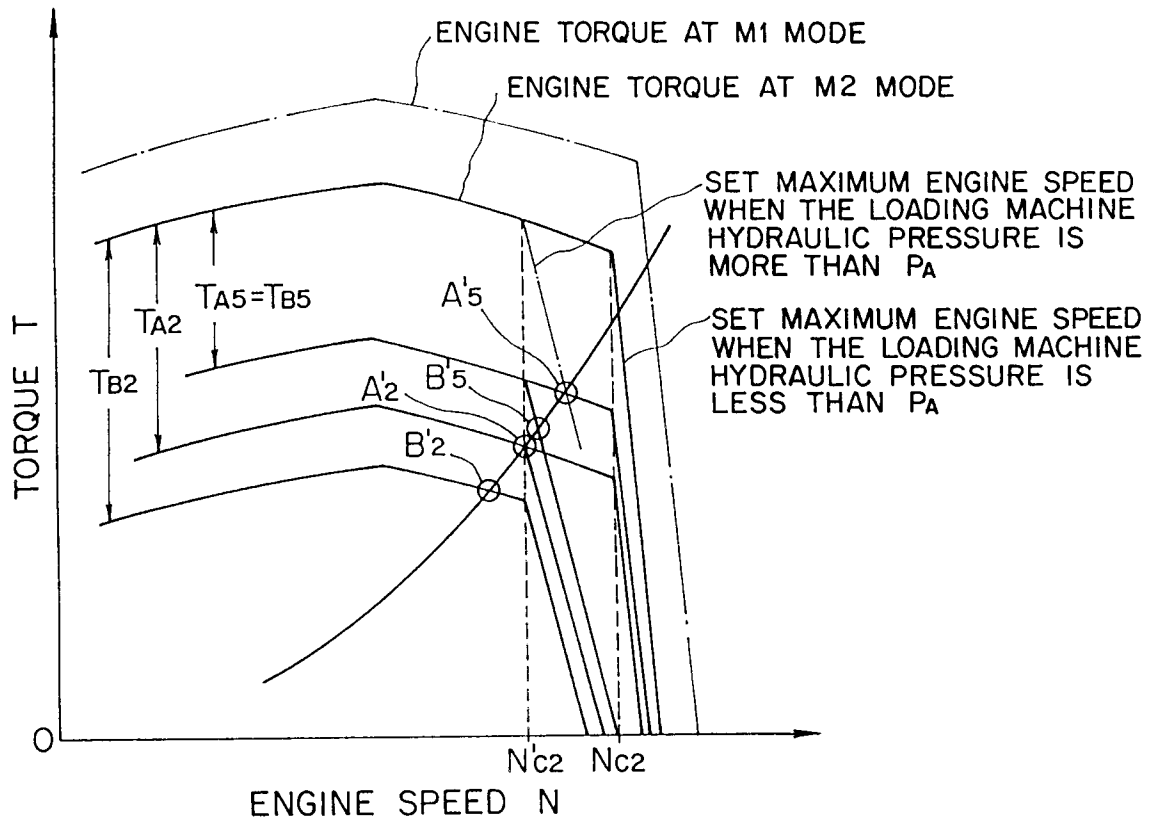


FIG. 3(c)

[M3 MODE & L3 MODE]

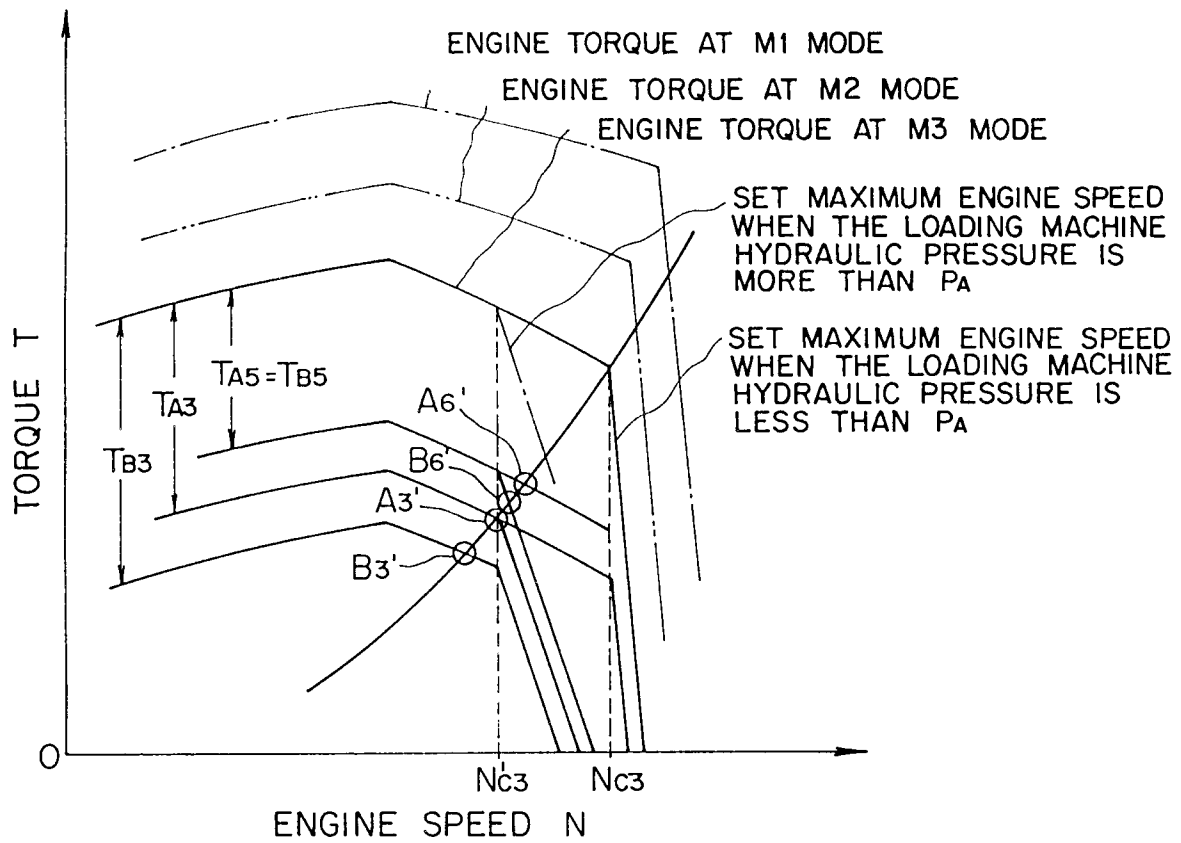


FIG. 4 (a)

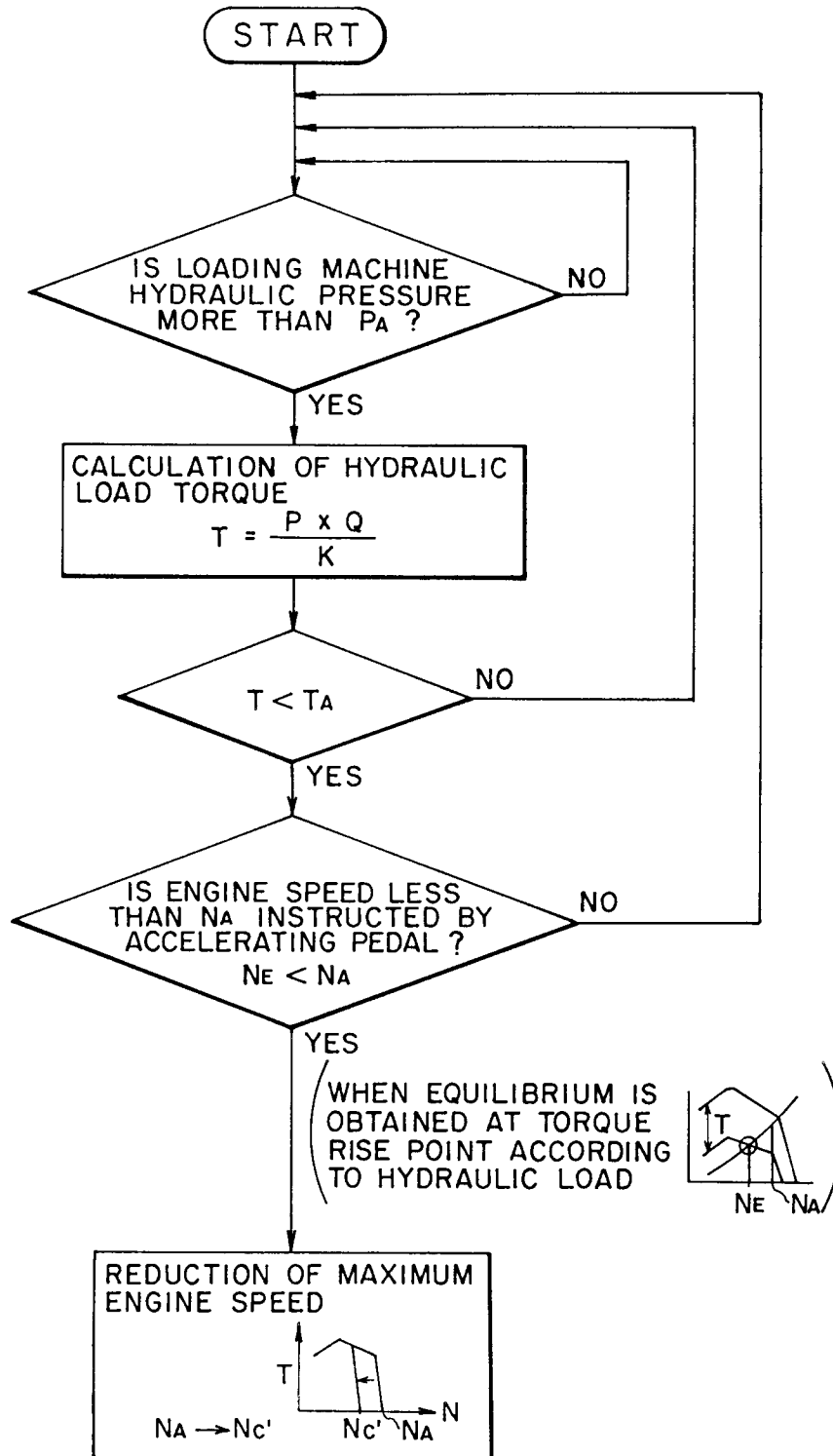


FIG. 4(b)

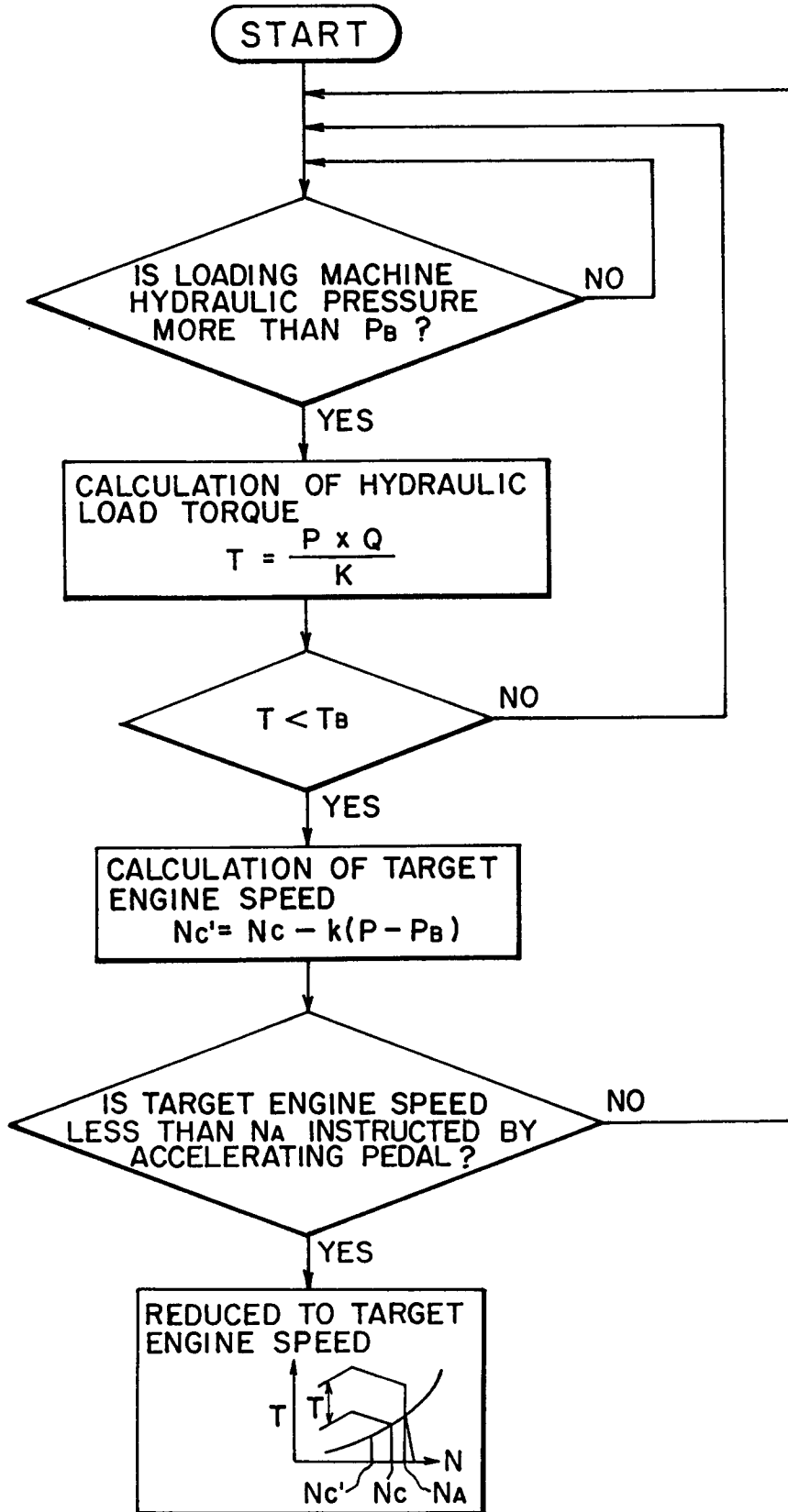


FIG. 5

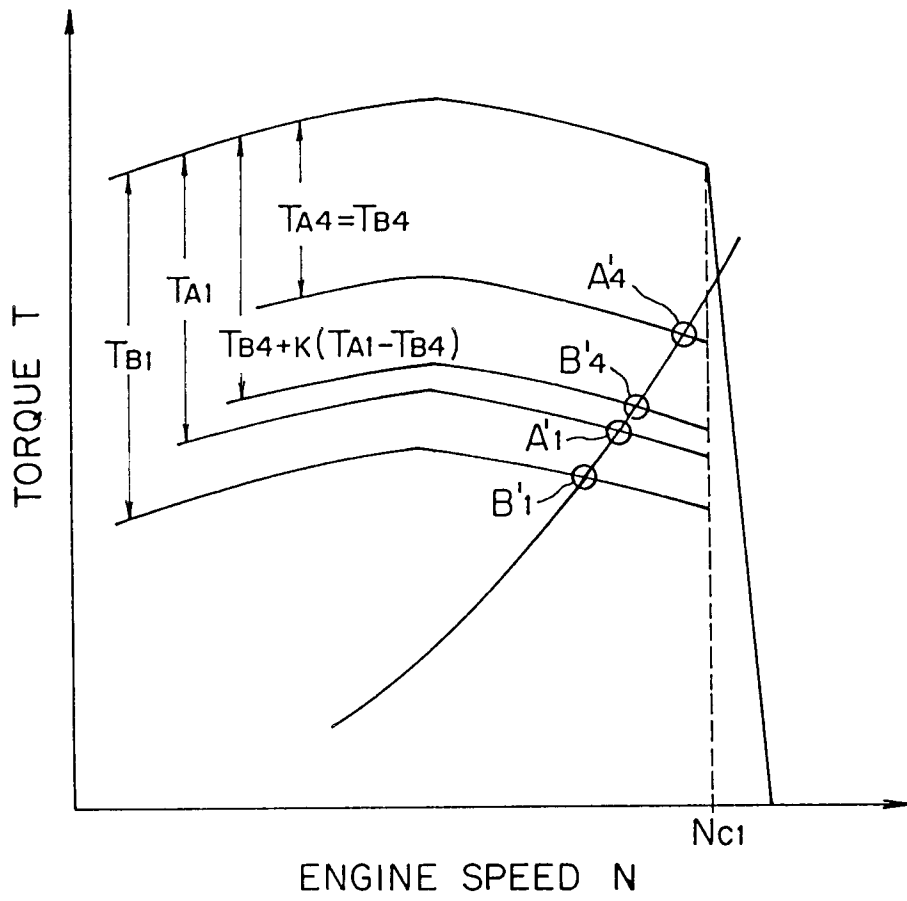


FIG. 6(a)

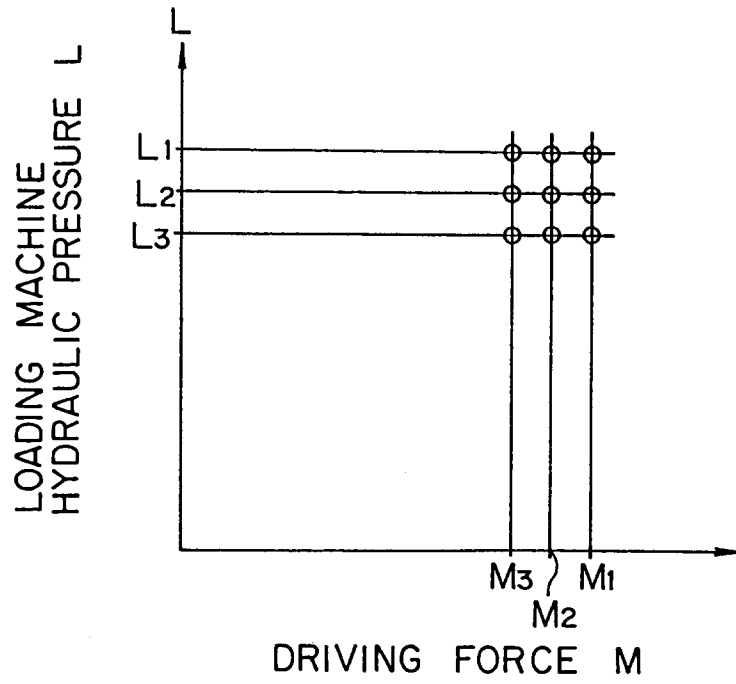


FIG. 6(b)

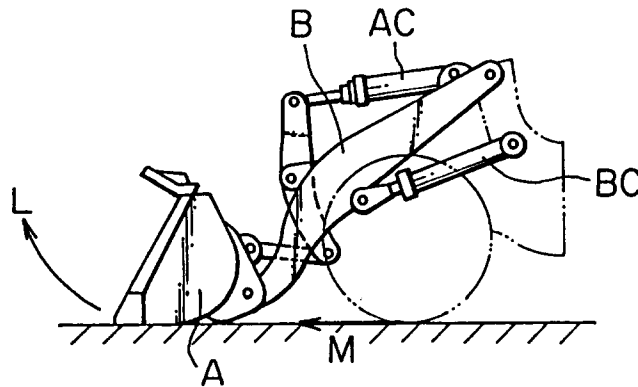


FIG. 7 (PRIOR ART)

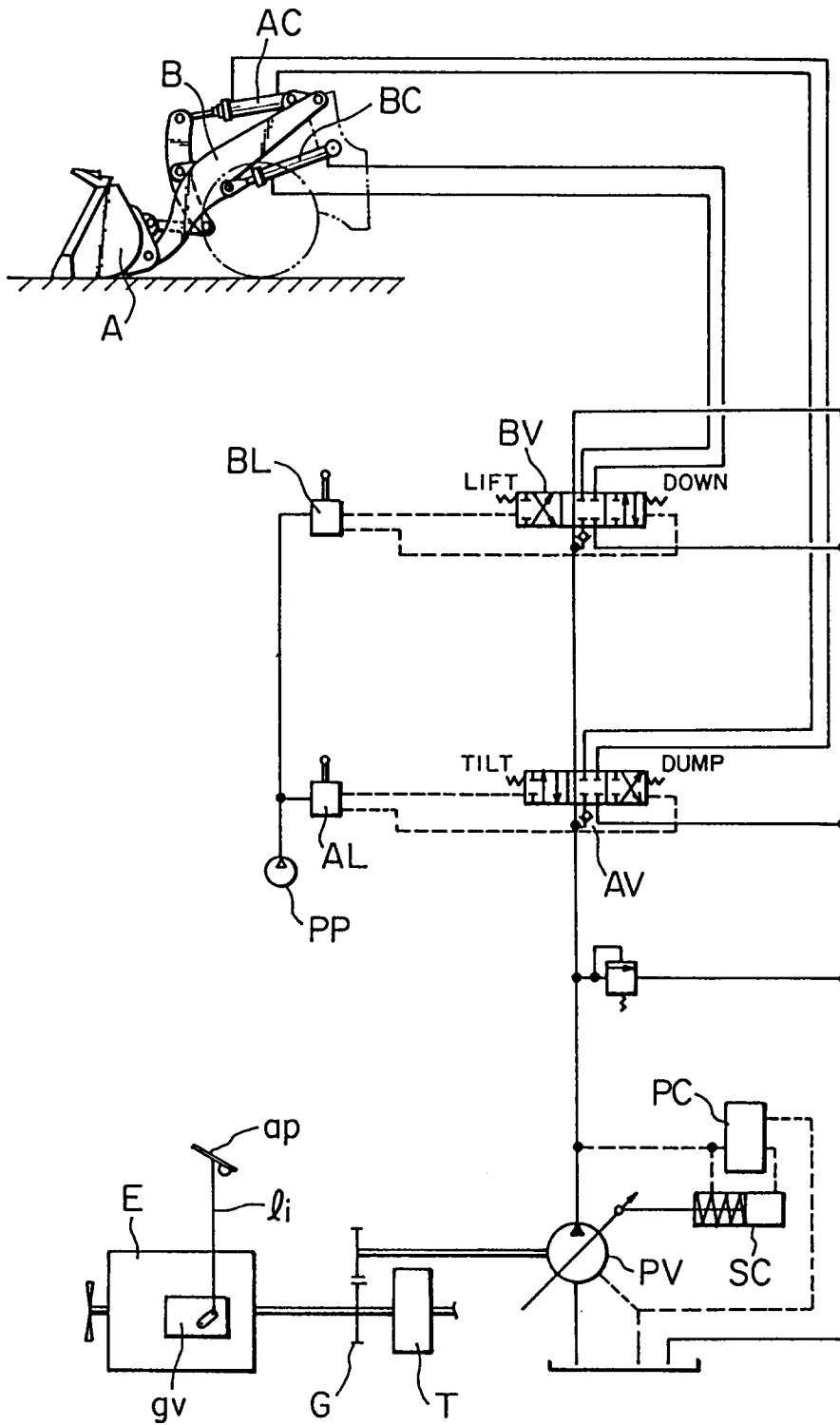


FIG. 8 (PRIOR ART)

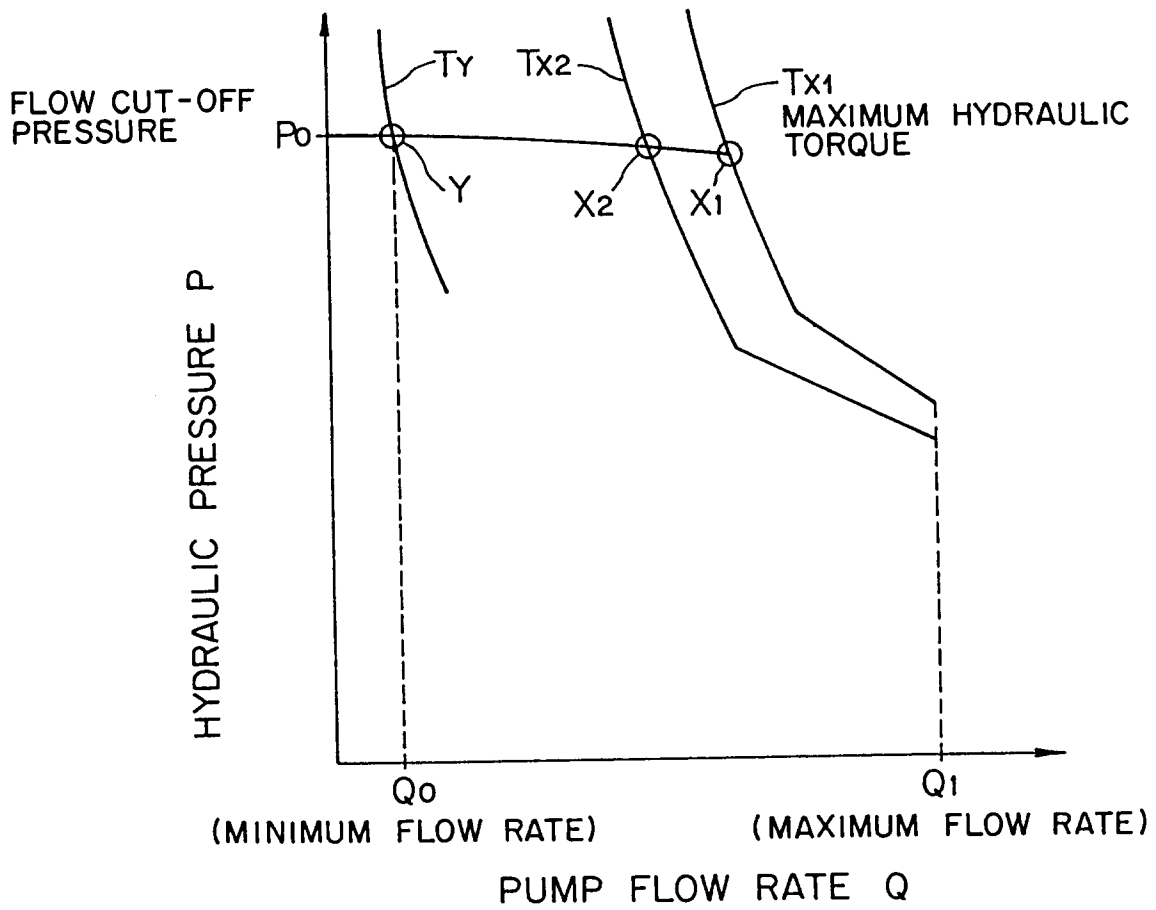
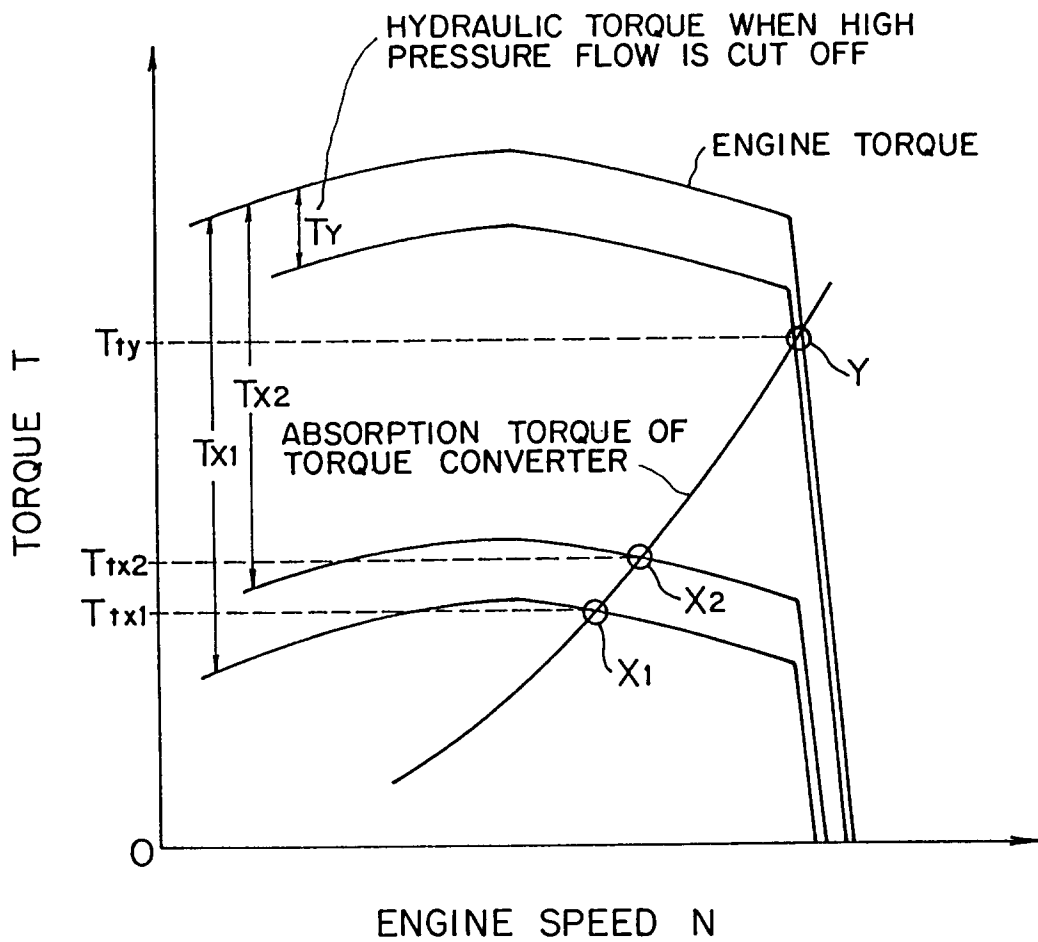


FIG. 9 (PRIOR ART)



## INTERNATIONAL SEARCH REPORT

International Application No PCT/JP91/00948

<b>I. CLASSIFICATION OF SUBJECT MATTER</b> (if several classification symbols apply, indicate all) <sup>6</sup>		
According to International Patent Classification (IPC) or to both National Classification and IPC		
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<b>II. FIELDS SEARCHED</b>		
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Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched <sup>8</sup>		
Jitsuyo Shinan Koho	1926 - 1991	
Kokai Jitsuyo Shinan Koho	1971 - 1991	
<b>III. DOCUMENTS CONSIDERED TO BE RELEVANT <sup>9</sup></b>		
Category <sup>*</sup>	Citation of Document, <sup>11</sup> with indication, where appropriate, of the relevant passages <sup>12</sup>	
	Relevant to Claim No. <sup>13</sup>	
Y	JP, A, 63-154874 (Komatsu Ltd.), June 28, 1988 (28. 06. 88), & EP, A1, 277253 & WO, A1, 8801349	1-2
Y	JP, A, 63-167042 (Hitachi Construction Machinery Co., Ltd.), July 11, 1988 (11. 07. 88), (Family: none)	1-2
A	JP, A, 63-186978 (Komatsu Ltd.), August 2, 1988 (02. 08. 88), & EP, A1, 344311 & WO, A1, 8805869	3
<p><sup>*</sup> Special categories of cited documents: <sup>10</sup></p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</p> <p>"&amp;" document member of the same patent family</p>		
<b>IV. CERTIFICATION</b>		
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September 26, 1991 (26. 09. 91)	October 14, 1991 (14. 10. 91)	
International Searching Authority	Signature of Authorized Officer	
Japanese Patent Office		