

(19)



Europäisches Patentamt

European Patent Office

Office européen des brevets



(11)

EP 0 553 347 B1

(12)

EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention
of the grant of the patent:

16.04.1997 Bulletin 1997/16

(21) Application number: **90903215.3**

(22) Date of filing: **20.02.1990**

(51) Int Cl.⁶: **E02F 9/22**

(86) International application number:
PCT/JP90/00195

(87) International publication number:
WO 91/13218 (05.09.1991 Gazette 1991/21)

(54) **HYDRAULIC DRIVING DEVICE OF CONSTRUCTION MACHINERY**

HYDRAULISCHE ANTRIEBSVORRICHTUNG FÜR BAUMASCHINEN

DISPOSITIF DE COMMANDE HYDRAULIQUE POUR ENGIN DE CHANTIER

(84) Designated Contracting States:
DE FR GB IT

(43) Date of publication of application:
04.08.1993 Bulletin 1993/31

(73) Proprietor: **KOMATSU, LTD.**
Minato-ku, Tokyo 107 (JP)

(72) Inventors:

- **MORIYA, Yukio**
Hirakata-shi, Osaka 573 (JP)
- **KOBAYASHI, Takeshi**
Hirakata-shi, Osaka 573 (JP)
- **ONODA, Takumi**
Hirakata-shi, Osaka 573 (JP)
- **TAKAMURA, Fujitoshi**
Hirakata-shi, Osaka 573 (JP)

- **YOKOYAMA, Toshio**
Hirakata-shi, Osaka 573 (JP)

(74) Representative: **Viering, Jentschura & Partner**
Postfach 22 14 43
80504 München (DE)

(56) References cited:
JP-A-55 078 805 **JP-A-58 213 927**
JP-A-62 160 331

- **PATENT ABSTRACTS OF JAPAN vol. 013, no. 189 (M-821) 8 May 1989 & JP-A-10 15 568 (KOBE STEEL LTD.) 19 January 1989**
- **PATENT ABSTRACTS OF JAPAN vol. 014, no. 335 (M-1000)(4278) 19 January 1990 & JP-A-21 15 421 (KOMATSU LTD.) 27 February 1990**

Note: Within nine months from the publication of the mention of the grant of the European patent, any person may give notice to the European Patent Office of opposition to the European patent granted. Notice of opposition shall be filed in a written reasoned statement. It shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

EP 0 553 347 B1

Description

TECHNICAL FIELD

The present invention relates to a method according to the preamble of Claim 1 and an equipment according to the preamble of Claim 5, for use in construction machinery such as a power shovel, shoveldozer and bulldozer. Among the working equipment are buckets, tilting apparatus, slewing apparatus etc.

BACKGROUND ART

In one known type of hydraulically-operated equipment such as travelling equipment and working equipment which are provided in the aforesaid construction machines according to the needs of various kinds of construction works including travelling and working operations, hydraulic pressure for actuating the hydraulic driving mechanism which is driven by hydraulic pressure in the hydraulically-operated equipment is supplied, at a constant supplying rate, to the pipeline system of the hydraulic driving mechanism, by means of hydraulic controller valves, hydraulic pumps and similar devices. In other words, the hydraulic driving mechanism is driven by hydraulic pressure, the pressure being supplied at such a constant supplying rate that it rises and drops rectilinearly.

Such hydraulically-operated equipment, however, has the following disadvantages: since hydraulic pressure is supplied at a constant supplying rate, when a high supplying rate is adopted, the hydraulic driving mechanism driven by hydraulic pressure abruptly starts or stops its operation immediately after the dead zone period in which hydraulic pressure starts to rise. As a result of this, the mechanism receives a great shock at the time of start-up and shut-down. On the other hand, when the supplying rate is low, the operation of the hydraulic driving mechanism driven by hydraulic pressure becomes sluggish so that there occurs a lag in the operation even though the mechanism can be free from a shock at the time of its start-up and shut-down.

This is a serious problem, particularly in the use of hydraulically-operated equipment in which more than two operation speed modes, e.g., a high travelling-speed mode, and low travelling-speed mode; and digging mode (i.e., normal speed mode) and moderating mode (i.e., half speed mode) can be selected. Because a great shock is caused at the time of start-up and shut-down with one mode whilst with the other mode, an operational lag occurs.

It is therefore a prime object of the invention to provide hydraulically-operated equipment for use in construction machinery, which is capable of overcoming the foregoing disadvantages by eliminating a shock at the time of start-up and shut-down and preventing a lag in the operation.

This object is achieved by the features recited in the

characterized clause in Claims 1 and 5.

According to the invention, the hydraulic pressure supplying rate at the hydraulic pipeline system, namely, the rising and dropping rates of hydraulic pressure are decreased during a specified period (represented by the period between I and II in Fig. 2) in the operating zone period, the specified period succeeding the dead zone period in which hydraulic pressure starts to rise. In other words, the motion of the hydraulic driving mechanism is made sluggish by decreasing the hydraulic pressure supplying rate in the specified period in which great momentum is imparted to the hydraulic driving mechanism. On the other hand, the motion of the hydraulic driving mechanism is made fast by maintaining the hydraulic pressure supplying rate to be high in the dead zone period and the operating zone period excluding the above specified period. During those periods, great momentum is not imparted to the hydraulic driving mechanism. The above arrangement makes it possible to prevent such an undesirable situation that the working state of the hydraulic driving mechanism is abruptly changed. Therefore, the entire operation of the hydraulic driving mechanism is carried out so smoothly that a shock which may occur at the time of start-up and shut-down is prevented. Further, a delay in the operation can be positively avoided since the operation of the hydraulic driving mechanism is kept at a high speed in the dead zone period and in the operating zone period excluding the specified period. In the case the equipment has more than two operation modes having different operation speeds, such an unfavourable situation that there occurs a shock with one mode at the time of start-up and shut-down whilst an operational lag occurs with the other mode will no longer happen.

Figs. 1 and 2 illustrate a preferable embodiment of hydraulically-operated equipment for construction machinery according to the invention. Fig. 1 is a block diagram of a hydraulic system and Fig. 2 graphically shows control modulation patterns.

Reference is now made to the drawings for explaining an embodiment of hydraulically-operated equipment for construction machinery according to the invention.

A construction machine with crawler belts which moves back and forth and slews freely such as a power shovel, for example, is provided with working equipment such as a bucket, tilting apparatus or slewing apparatus which is hydraulically-operated equipment. Such working equipment has a hydraulic system as shown in Fig. 1.

In Fig. 1, an operation signal generated according to the operating conditions of a control lever 1 consisting of an electric lever is supplied to a controller 2. The above operating conditions are, concretely, rapid operation (represented by the dashed line a in Fig. 2), normal operation (the dashed line b), slow operation (the dashed line c) and reverse operation (the dashed line z). Those operations are carried out at control speeds in the range from the minimum value "0" to the maximum

value "full stroke" and will be described later in detail. The controller 2 is also provided with set mode signals from an automatic mode setting section 3 and a manual mode-change-over switch 4. The set mode signals are each based on one of operation modes such as an digging mode, moderating mode etc., the operation mode being specified by the automatic mode setting section 3 or the manual mode-change-over switch 4. The automatic mode setting section 3 is for automatically selecting one operation mode according to operational requirements for the construction machine and particularly the working equipment. The manual mode-change-over switch 4 is operated by the operator to select one of the above operation modes in accordance with the working state of the machine. In accordance with the operation signal from the control lever 1 and the set mode signals from the automatic mode setting section 3 and the manual mode-change-over switch 4, the controller 2 controls the rate at which hydraulic pressure is supplied to the hydraulic pipeline system of a hydraulic driving system 5 provided in a bucket, tilting apparatus or slewing apparatus, by selecting one of preset control modulation patterns (in this embodiment, three patterns are preset). More specifically, the pumping rate of a hydraulic pump 7 actuated by a travel engine 6 for driving the construction machine to travel back and forth and slew and the spool drive of a hydraulic controller valve 8 for determining the flow path and flow rate of hydraulic oil pressurised by the hydraulic pump 7 are increased or decreased whereby the controller 2 controls the hydraulic pressure supplying rate according to selected one of the control modulation patterns.

When the operator specifies a setting which allows the operation modes to be selectively changed by the manual mode-change-over switch 4, the controller 2 processes the set mode signal sent from the manual mode-change-over switch 4 in preference to the set mode signal from the automatic mode setting section 3.

Now there will be given an explanation on the relationship between the operation modes to be selected by the automatic mode setting section 3 or the manual mode-change-over switch 4 and the three control modulation patterns installed in the controller 2 whilst making reference to Fig. 2. The continuous lines A, B and Z represent the three types of control modulation patterns.

As shown in Fig. 2, except for the dead zone period (the initial period) in which hydraulic pressure starts to rise and the latter operating zone period (the closing period) during which great momentum is not imparted to the hydraulic driving mechanism 5, each of the control modulation patterns A, B and Z achieves satisfactory operational effects after the rise of hydraulic pressure. In the former operating zone period (the middle period from I to II) during which great momentum is imparted to the hydraulic driving mechanism 5, this period being at the middle of the stroke and accounting for about 30% of it in this embodiment, the hydraulic pressure supplying rate is set less than those of the other periods. In

short, in the former operating zone period during which great momentum is imparted to the hydraulic driving mechanism 5, the movement of the hydraulic driving mechanism 5 is restrained thereby preventing a shock caused at the time of start-up and shut-down. On the other hand, in the dead zone period and the latter operating zone period during which the hydraulic driving mechanism 5 is not subject to great momentum, the hydraulic pressure supplying rate is not decreased but maintained to be high so that an operational lag is prevented. Decreasing the hydraulic pressure supplying rate in the former operating zone period can prevent not only a shock but also cavitation which may be caused in the hydraulic pipeline system by the hydraulic pump 7.

The controller 2 selects, in the following manner, one of the control modulation patterns A, B and Z in accordance with the operation mode specified by the automatic mode setting section 3 or the manual mode-change-over switch 4.

Taking working equipment for a power shovel for instance, with the digging mode, the control modulation pattern B is selected so that no great shock will occur and the operation will be carried out in a smooth and gentle manner in the course of heavy digging operation. With the moderating mode on the other hand, the control modulation pattern A is selected so that there will occur no operational lag. Regarding travelling equipment, when the high travelling-speed mode is set, the control modulation pattern B causing less shocks is selected to reduce the influence of inertia, and when the low travelling-speed mode is selected, the control modulation pattern A causing no operational lag is selected. When the control lever 1 is reversely operated such that the control speed drops from a "full stroke" value to "0", the control modulation pattern Z is always selected regardless of the operation mode that has been set or specified.

Referring to Fig. 2, the control operation of the hydraulic pressure supplying rate will be explained in connection with the relationship between the control modulation patterns A, B and Z to be selected and the operating conditions of the control lever 1.

In Fig. 2, the dashed line a represents the rapid operating condition in which the control lever 1 is operated such that the speed at which hydraulic pressure is controlled increases from its minimum value (i.e., "0") to its maximum value (i.e., "full stroke" value) in an instant, thereby instantaneously increasing the hydraulic pressure supplying rate. The dashed line c represents the slow operating condition in which the control lever 1 is operated such that the control speed increases slowly from "0" to the "full stroke" value, thereby gradually increasing the hydraulic pressure supplying rate. The dashed line b represents the normal operating condition in which the control speed is intermediate between those of the rapid operating condition and the slow operating condition. The dashed line z represents the reverse operating condition in which the control speed decreases with a profile similar to that of the rapid operat-

ing condition when it is inverted. In the rapid operating condition represented by the dashed line a, the normal operating condition represented by the dashed line b and the reverse operating condition represented by the dashed line c, if hydraulic pressure is supplied at a constant supplying rate as indicated by the respective straight dashed lines a, b and c, a shock will inevitably occur at the time of the start-up and shut-down of the hydraulic driving mechanism 5. The shock is considerably great especially in the rapid and reverse operating conditions since the control speed of the control lever 1 instantaneously reaches the "full stroke" value or "0".

If the control modulation pattern A is selected on the basis of a selected operation mode when the control lever 1 is in the rapid operating condition indicated by the dashed line a, the hydraulic pressure supplying rate will be controlled in compliance with the control modulation pattern A. If the control modulation pattern A is selected when the control lever 1 is in the normal operating condition or slow operating condition indicated by the dashed lines b and c respectively, the hydraulic pressure supplying rate will continue to be controlled in compliance with the pattern of the respective operating conditions. This arrangement enables the operational lag of the hydraulic driving mechanism 5 and the occurrence of a shock to be prevented at least in the rapid operating condition.

If the control modulation pattern B is selected when the control lever 1 is in the rapid operating condition or normal operation condition indicated by the dashed lines a and b respectively, the supplying rate will be controlled in compliance with the control modulation pattern B. If the control modulation pattern B is selected when the control lever 1 is in the slow operating condition indicated by the dashed line c, the supplying rate will continue to be controlled in compliance with the pattern of the slow operating condition. With the above arrangement, the operational lag of the hydraulic driving mechanism 5 and the occurrence of a shock can be prevented both in the rapid and normal operating conditions.

Similarly, if the control modulation pattern Z is selected when the control lever 1 is in the reverse operating condition represented by the dashed line c, the hydraulic pressure supplying rate will be controlled in compliance with the control modulation pattern Z so that the operational lag and the occurrence of a shock can be prevented.

In the above embodiment, the rate at which hydraulic pressure is supplied to the hydraulic pipeline system is decreased in a specified period after the dead zone period in which hydraulic pressure starts to rise, according to the preset control modulation patterns A, B and Z, however the invention is not necessarily limited to this arrangement. For example, the supplying rate may be decreased in a specified period under the calculation directly from the respective patterns of the operating conditions of the control lever 1 whereby an operational lag and the occurrence of a shock are prevented.

The arrangement disclosed in the invention is capable of preventing a shock which may occur at the time of the start-up and shut-down of the hydraulic driving mechanism as well as an operational lag, and therefore it is most suitably applied not only to working equipment for construction machinery such as a bucket, tilting apparatus, slewing apparatus but also to travelling equipment for construction machinery.

Claims

1. A method of controlling hydraulically-operated equipment in a construction machine, the equipment comprising a hydraulic driving mechanism (5) actuated by hydraulic pressure supplied by a hydraulic pipeline system, and a hydraulic pressure supplying means (7) for supplying hydraulic pressure to the hydraulic pipeline system for the hydraulic driving mechanism (5), the method comprising:

supplying hydraulic pressure to the hydraulic pipeline system at a first rate of increase during a dead zone period (0-I) in which the hydraulic pressure starts to rise without causing movement of the hydraulic driving mechanism (5), and

decreasing the rate at which hydraulic pressure is supplied to the hydraulic pipeline system immediately after the dead zone period, to reduce shock to the hydraulic driving mechanism (5) upon start-up of the mechanism (5).

2. The method according to claim 1, characterized in that in the case of deceleration supplying hydraulic pressure to the hydraulic pipeline system at a first rate of decrease in a third zone period (Full Stroke-I') in which the hydraulic pressure starts to decrease;

and decreasing the rate in a forth zone period (I'-II') at which hydraulic pressure is decreased in the hydraulic pipeline system after the third zone period until the piston has come to rest; and increasing the rate in a fiftieth zone period (II'-0) compared to the forth zone period.

3. The method of controlling hydraulically-operated equipment according to claim 1, wherein the rate at which hydraulic pressure is supplied to the hydraulic pipeline system is reduced for a predetermined period (I-II).
4. The method of controlling hydraulically operated equipment according to the claim 1, characterized in that a period following after the predetermined period (I-II), the hydraulic pressure is increased in comparison with said predetermined period.

5. Hydraulically-operated equipment for construction machinery for carrying out the method according to claims 1-4, comprising:

(a) a hydraulic driving mechanism (5) actuated by hydraulic pressure supplied by hydraulic pipeline system;
 (b) a hydraulic pump (7) for supplying hydraulic pressure to the hydraulic pipeline system for the hydraulic driving mechanism;
 (c) a controller (2,8); characterized in that the controller is operatively connected to the hydraulic pump and a hydraulic controller valve.

Patentansprüche

1. Verfahren zum Steuern einer hydraulisch betriebenen Vorrichtung in einer Baumaschine, wobei die Vorrichtung einen hydraulischen Antriebsmechanismus (5), der mittels über ein Hydraulikleitungssystem zugeführten Hydraulikdruckes betätigt wird, und ein Hydraulikdruckzufuhrmittel (7) zum Zuführen von Hydraulikdruck an das Hydraulikleitungssystem für den hydraulischen Antriebsmechanismus (5) aufweist, wobei das Verfahren die folgenden Schritte aufweist:

Zuführen von Hydraulikdruck an das Hydraulikleitungssystem bei einer ersten Anstiegsrate während einer Totzeitperiode (0-I), in der der Hydraulikdruck anzusteigen beginnt, ohne daß er eine Bewegung des hydraulischen Antriebsmechanismus (5) verursacht, und Absenken der Rate, mit der der Hydraulikdruck an das Hydraulikleitungssystem zugeführt wird, unmittelbar nach der Totzeitperiode, so daß ein auf das Starten des Mechanismus (5) hin auf den hydraulischen Antriebsmechanismus (5) ausgeübter Stoß reduziert wird.

2. Verfahren gemäß Anspruch 1, dadurch gekennzeichnet, daß im Falle der Verlangsamung in einer dritten Zeitspanne (Vollgas-I'), in der der Hydraulikdruck abzunehmen beginnt, an das Hydraulikleitungssystem Hydraulikdruck bei einer ersten Verminderungsrate zugeführt wird;

und die Rate in einer vierten Zeitspanne (I'-II'), in der der Hydraulikdruck in dem Hydraulikleitungssystem vermindert wird, nach der dritten Zeitspanne bis der Zylinder zum Stillstand gekommen ist, vermindert wird;
 und die Rate in einer fünften Zeitspanne (II'bis 0) im Vergleich zu der vierten Zeitspanne erhöht wird.

3. Verfahren zum Steuern einer hydraulisch betriebenen

Vorrichtung gemäß Anspruch 1, wobei die Rate, mit der Hydraulikdruck an das Hydraulikleitungssystem zugeführt wird, für eine vorbestimmte Zeitspanne (I-II) vermindert wird.

4. Verfahren zum Steuern einer hydraulisch betriebenen Vorrichtung gemäß Anspruch 1, dadurch gekennzeichnet, daß in einer auf die vorbestimmte Zeitspanne (I-II) folgenden Zeitspanne der Hydraulikdruck im Vergleich zu der vorbestimmten Zeitspanne erhöht ist.

5. Hydraulisch betriebene Vorrichtung für eine Baumaschine zum Ausführen der Verfahren gemäß einem der Ansprüche 1 bis 4, die aufweist:

(a) einen hydraulischen Antriebsmechanismus (5), der mittels über ein Hydraulikleitungssystem zugeführten Hydraulikdrucks angetrieben wird;
 (b) eine Hydraulikpumpe (7) zum Zuführen von Hydraulikdruck an das Hydraulikleitungssystem für den hydraulischen Antriebsmechanismus;
 (c) eine Steuervorrichtung (2,8);

dadurch gekennzeichnet, daß die Steuervorrichtung im Einsatz an die Hydraulikpumpe und ein Hydrauliksteuerventil angeschlossen ist.

Revendications

1. Procédé pour la commande d'un système hydraulique dans une machine de chantier, le système comprenant une commande hydraulique (5) qui est actionnée par une pression hydraulique alimentée par un système de conduites hydrauliques, et un moyen d'alimentation de la pression hydraulique (7) pour alimenter de la pression hydraulique au système de conduites hydrauliques pour la commande hydraulique (5), le procédé comprenant:

alimenter de la pression hydraulique au système de conduites hydrauliques à une première valeur d'augmentation pendant une période de temps de retard (0 à I), pendant laquelle la pression hydraulique commence à augmenter sans qu'un mouvement du système de commande hydraulique (5) soit effectué, et diminuer la valeur à laquelle la pression hydraulique est alimentée au système de conduites hydrauliques directement après la période de temps de retard pour réduire le choc pour le système de commande hydraulique (5) comme réaction à la démarrage du mécanisme (5).

2. Procédé selon la revendication 1, caractérisé en ce

que, dans le cas de ralentissement, alimenter de la pression hydraulique au système de conduites hydrauliques à une première valeur de diminuation dans une troisième période (plein régime à I') dans laquelle la pression hydraulique commence à diminuer; 5

et diminuer la valeur dans une quatrième période (I' à II') à laquelle la pression hydraulique est diminuée dans le système de conduites hydrauliques après la troisième période jusqu'au moment que le piston est arrêté; 10
et augmenter la valeur dans une cinquième période (II' à 0) par rapport à la quatrième période. 15

3. Procédé pour la commande d'un système hydraulique selon la revendication 1, la valeur, à laquelle la pression hydraulique est alimentée au système de conduites hydrauliques, est diminuée pour une période prédéterminée (I à II). 20

4. Procédé pour la commande d'un système hydraulique selon la revendication 1, caractérisé en ce que une période suivant la période prédéterminée (I à II) la pression hydraulique est augmentée par rapport à ladite période prédéterminée. 25

5. Système hydraulique pour une machine de chantier pour effectuer le procédé selon l'une de revendications 1 à 4, comprenant: 30

(a) un mécanisme de commande hydraulique (5) actionné par la pression hydraulique augmentée par un système de conduites hydrauliques; 35

(b) une pompe hydraulique (7) pour alimenter de la pression hydraulique au système de conduites hydrauliques pour le mécanisme de commande hydraulique; 40

(c) un appareil de commande (2,8); 40

caractérisé en ce que l'appareil de commande est effectivement raccordé à la pompe hydraulique et une vanne hydraulique à commande. 45

50

55

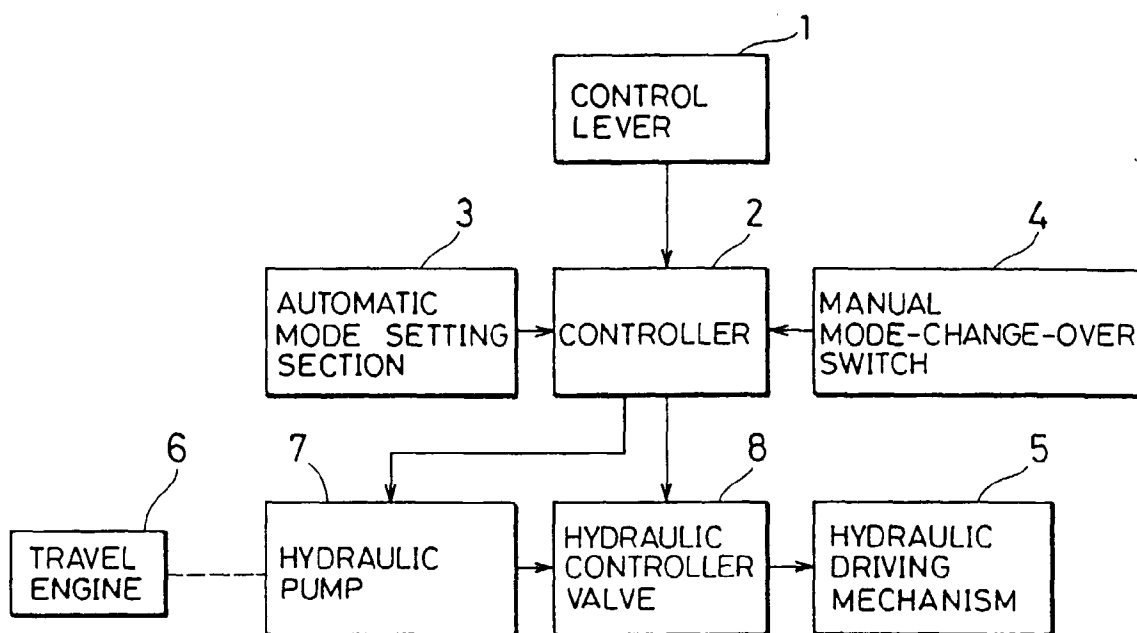


FIG. 1

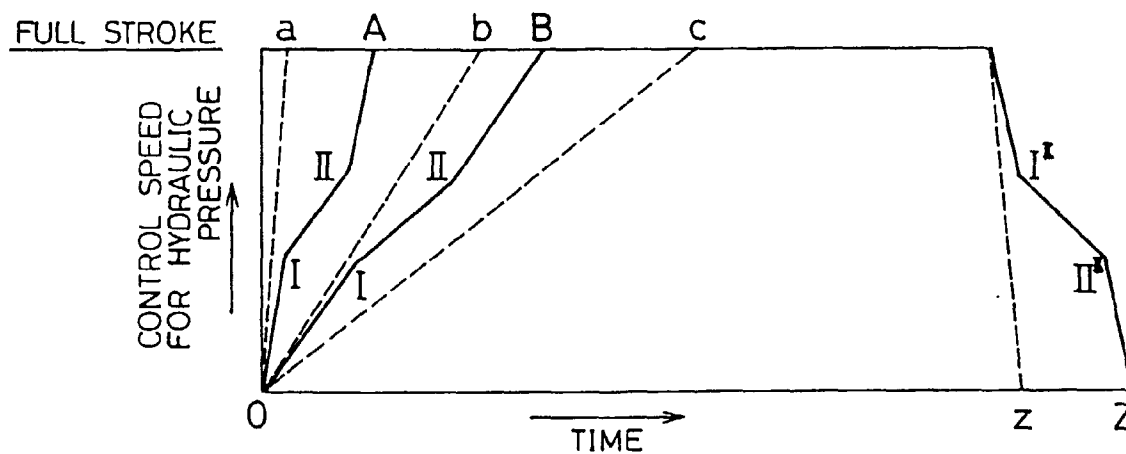


FIG. 2